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NUTRITION

An Elementary Text

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PREFACE

There have been many excellent nutrition books written by American and British authors but none that entirely expressed the Canadian viewpoint. Although fundamental scientific data on nutrition are common to our three countries, the Canadian interpretation of these data differs from that of the other two in many respects.

Teachers who have tried to present the Canadian material have been hampered by the lack of a Canadian text containing Canadian data put together in a form that made for easy reference. It is my hope that this small book will meet this need.

I wish to express my grateful thanks to the University of Manitoba for making it possible for me to write this book. It was through the loyal co-operation of the Department of Foods and Nutrition that I was enabled to set up the exhibits which form so many of the illustrations. I wish particularly to thank Mr. and Mrs. S. K. Watson for taking the pictures of the food exhibits and the rats. Their generous assistance, freely given, made this part of the book possible.

Other illustrations have been reproduced with the kind permission of: The Department of National Health and Welfare (Figures 1, 2, 3, 8, 12, 14, 16, 23, 28, 31, 32); H.M.S.O. (Figures 17, 18, 19, 20); the *Biochemical Journal* (Figure 21); the Government of Kenya (Figures 9 and 10); the Ralston Purina Co. (Figure 29) and The Associated Milk Foundations (Figure 35). Appendix 5 has been adapted from tables printed by Health Publications Institute, Inc.

This book is intended to be an elementary text on nutrition suitable for senior high school and junior college students, and public health nurses.

Mary C. Hiltz
University of Manitoba

April 1, 1955

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CANADIAN MATERIAL USEFUL AS GENERAL REFERENCE

There is a great deal of useful material, along nutrition lines, eing published all the time by the Department of National Health nd Welfare, Ottawa. This material is distributed through the rovincial Departments of Health and Welfare. The Provincial epartments also publish some material of their own. The Proincial Nutritionist will gladly send material in answer to a written equest. She is also the distributor of the National Film Board ilms and film strips.

The following Canadian publications should be in the classroom of every nutrition teacher:

Tables of Food Values Recommended for Use in Canada. 2nd ed., 1951.
Canadian Nutrition Notes (monthly).
Food and Drugs Act and Regulations (Ottawa) 1954.
Canadian Home Economics Journal (quarterly).

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Chapter 1.

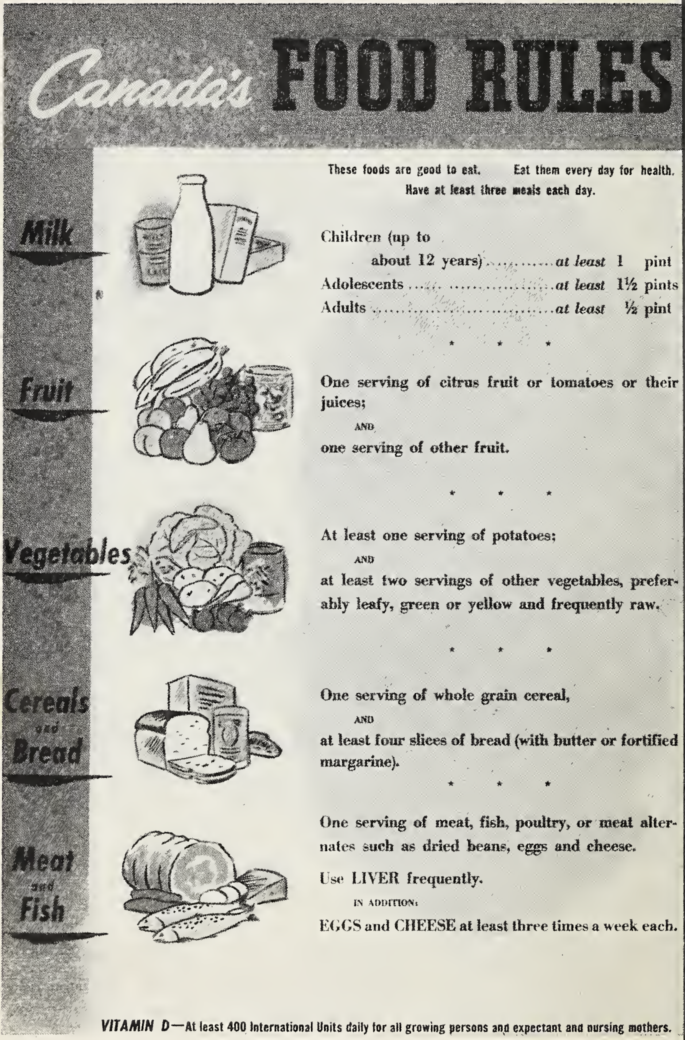
FOOD AND HEALTH

In Canada we have plenty of food of the right quality to feed our people well. According to the *Canada Year Book* for 1954, the average Canadian consumes over 1,000 lb. of food (about 3 lb. daily) at the retail level during the year. This includes liberal amounts of milk, meat, cereals, fruits, and vegetables, as well as many other foods as listed in Table 1.

TABLE 1. FOODS SUPPLIED PER PERSON ANNUALLY AT RETAIL LEVEL

	LB.
Cereals	168
Potatoes	171
Sugars and syrups	104
Pulses and nuts	10
Fruit	210
Vegetables	88
Oils and fats	44
Meat	129
Poultry and fish	26
Eggs	34
Milk (solids) and cheese	64
Beverages	9
	1,057 lb. yearly

This is a very large amount of food. One would expect that it would mean that every Canadian would be healthy and strong. Unfortunately this is not the case because every Canadian does not know the proper sort of food to provide a healthy body, and although he may eat a large quantity of food, it may not be the



Canada's FOOD RULES

These foods are good to eat. Eat them every day for health.
Have at least three meals each day.

Milk

Children (up to about 12 years)	*at least*	1 pint
Adolescents	*at least*	1½ pints
Adults	*at least*	½ pint

* * *

Fruit

One serving of citrus fruit or tomatoes or their juices;

AND

one serving of other fruit.

* * *

Vegetables

At least one serving of potatoes;

AND

at least two servings of other vegetables, preferably leafy, green or yellow and frequently raw.

* * *

Cereals and Bread

One serving of whole grain cereal,

AND

at least four slices of bread (with butter or fortified margarine).

* * *

Meat and Fish

One serving of meat, fish, poultry, or meat alternates such as dried beans, eggs and cheese.

Use LIVER frequently.

IN ADDITION:

EGGS and CHEESE at least three times a week each.

VITAMIN D—At least 400 International Units daily for all growing persons and expectant and nursing mothers.

(Nutrition Division, Department of National Health and Welfare, Ottawa)

FIGURE 1. CANADA'S FOOD RULES

right kind. The best foods to choose every day are listed in Canada's Food Rules. These rules mention only the important foods, but other foods may be eaten too, if desired, after a choice of the essentials has been made from the foods listed in Canada's Food Rules. The reasons for emphasizing these five groups in relation to health will be apparent later on when the nutrients have been discussed.

Methods Used to Judge the Health of Canadians

1. Statistics. By studying vital statistics, some very interesting data may be found. The 1954 *Canada Year Book* gives the following information: In 1947, the "life expectancy" for a boy one year old was 68 years, and for a girl, 71 years. In 1921, the average age at death of males was 39.0 years, and of females, 41.1 years.

The natural increase per 1,000 population (excess of births over deaths) in Canada in 1951 was 18.2, while for France, it was only 6.2. This was due partly to an increased birth-rate in Canada, but not altogether, since the death-rate in France was higher than in Canada. Undoubtedly Canada is a healthy place to live in, due partly to improved public health measures, but also due to an abundance of good food. One look at the list on page 1 will show the varied diet eaten by the average Canadian.

2. Dietary Survey. This is a method of finding out what foods are eaten by families in a certain section of the country. The number of families chosen for this study must be large enough, and must represent different types, if the results are to be of use. The amount of food at the beginning of the experimental period must be listed, a record kept of the amount bought during the period (1 week-10 days) and the amount left over subtracted from the total. The nutrients in the food eaten are then compared with standards of what the families should have used during that period. This is a rough estimate, but is a useful tool in judging food habits. If large-scale surveys are not possible, individuals may check their own eating habits by using the score sheet on pages 4 and 5.

3. Physical Examination. A complete physical examination by

FIGURE 2

SCORE SHEET FOR EACH DAY'S MEALS

FOOD AND CREDITS (The maximum score for each group is 20)		Your Score							Food Group Average
MILK — fluid milk (see 1), cheese (see 2), milk dishes (see 3)	20								
Children: 3 cups........20 · Adolescents: 4 cups..........20 · Adults: 2 cups.........20									
Children: 2½ cups........15 · Adolescents: 3 cups..........15 · Adults: 1½ cups.........15									
Children: 2 cups........10 · Adolescents: 2 cups..........10 · Adults: 1 cup.........10									
Children: 1 cup........ 5 · Adolescents: 1 cup.......... 5 · Adults: ½ cup.........5									
FRUIT (see 4)	20								
1 serving of citrus fruit or tomatoes or their juices (see 5)	15								
1 or more servings of other fruit — fresh, canned, dried or frozen	5								
VEGETABLES (see 4)	20								
3 or more servings (one should be potatoes)	15								
2 servings..........10									
1 serving.......... 5									
If one or more servings are green, leafy, yellow or raw, extra	5								
Include fresh, canned, dried and frozen vegetables.									
CEREALS, BREAD (see 4)	20								
1 or more servings of whole-grain cereal	8								
Bread (not more than 4 slices may be scored)	8								
Ordinary white, 1 point per slice.......... 4									
Nutritionally improved (see 6), 2 points per slice.......... 8									
Butter or fortified margarine	4								

MEAT, FISH, POULTRY OR MEAT ALTERNATES (see 7)	20								
1 or more servings of meat, fish, poultry or meat alternates such as eggs and cheese	15								
Extra for liver, heart or kidney	5								
Eggs (if not scored as meat alternate)	5								
Cheese (if not scored as meat alternate or in milk group)	5								
VITAMIN D PREPARATIONS — liquid, capsules, tablets or drops									
For Children and Adolescents	10								
MAXIMUM SCORE — Adults	100								
Children and Adolescents	110								

AVERAGE SCORE FOR WEEK ________

For Children and Adolescents:

A score of 95 or over is very good.

A score of 80-94 is good.

A score below 80 is only fair, try to improve.

For Adults:

A score of 85 or over is very good.

A score of 70-84 is good.

A score below 70 is only fair, try to improve.

FOOTNOTES

1. A cup is an 8 fluid ounce measuring cup. A pint is 20 fluid ounces or 2½ cups.
2. Cheese, two one-inch cubes can be scored as ½ cup milk.
3. Milk dishes (cream soup, milk puddings) can be scored as ½ cup milk.
4. An average serving of vegetable, fruit or cereal is ½ cup. Servings will be smaller for children.
5. VITAMINIZED apple juice can be used in place of citrus fruit or tomatoes or their juices.
6. A nutritionally improved bread contains such foods as whole wheat, wheat germ, rye, dried milk, oatmeal, raisins, Vitamin B white flour (Canada Approved).
7. Meat alternates — 2 eggs, 1 cup baked beans, three one-inch cubes of cheese.

Prepared by the Nutrition Division, Department of National Health and Welfare, Ottawa, Revised 1950.

a competent physician (which includes a check on foods eaten) is the best method of estimating the health of individuals.

Part of this physical examination is an investigation of the height and weight of the individual in relation to age and sex. A very comprehensive survey of this type on Canadians was completed in 1953. Part of the data accumulated at that time will be found in Appendix 1. A "skin-fold technique", a method of measuring fatty tissue by means of calipers, was also used at this time.

The Canadian survey was very carefully planned by the Dominion Bureau of Statistics (DBS), so that a true sample of the Canadian population would be examined. About 22,000 individuals were weighed and measured and it is estimated that this represents the population to an accuracy of about 5%. The actual survey, as well as interpretation of the data, was made by the Nutrition Division of the Department of National Health and Welfare.

The figures given in the Appendix should be used with caution. They are true averages of our Canadian population but that does not necessarily mean that they are ideal for each individual. Where children are concerned, the best method to check weight and height is undoubtedly in comparison with their previous measurements. A small-boned child may weigh much less than the average for his height and age, and likewise a large-boned child may be heavier than the average. Both may be healthy individuals.

It should also be remembered that adults have a tendency to gain weight as they get older. Insurance companies consider that the best "risk" is the person who remains close to his ideal weight at the age of 30 years.

All three methods give information of value in judging the health of Canadians. The statistical method allows for comparison with other countries, the dietary survey checks the food habits and the physical examination is an intensive and detailed study of the individual.

EXERCISE

Check your own food habits for one week, using Canada's Score Sheet.

REFERENCES

Canada Year Book, 1954.

FAO Nutritional Studies, No. 4. Dietary Surveys: Their Technique and Interpretation.

Macbeth, Mary E. Canadian Average Weights for Height, Age and Sex. *Can. Home Ec. J.* 5, 3. 1955.

Chapter 2.

FOODS—THEIR COMPOSITION AND FUNCTIONS

Nutrients

No matter what the food is or how complex it appears, it can be broken down chemically into many parts. A common classification of the chemical parts of food is as follows:

1. Protein
2. Fat
3. Carbohydrate
4. Mineral matter
5. Water
6. Vitamins

However, today these parts are broken into smaller ones, and the general term "nutrient" is applied whether it is calcium, or fat, or Vitamin A, or any one of the 50-odd parts into which the 6 groups above may be divided. Protein alone has 20 parts or amino acids, mineral matter has 14, and the vitamins have already progressed to 16, with (presumably) more in the offing. Some of these parts are more important than others, and in food composition tables there will usually be only 11 columns, since these are the important ones at the present time. Perhaps in the future some nutrients that we ignore today may prove to be important, but at present we are content with 11.

Food Tables

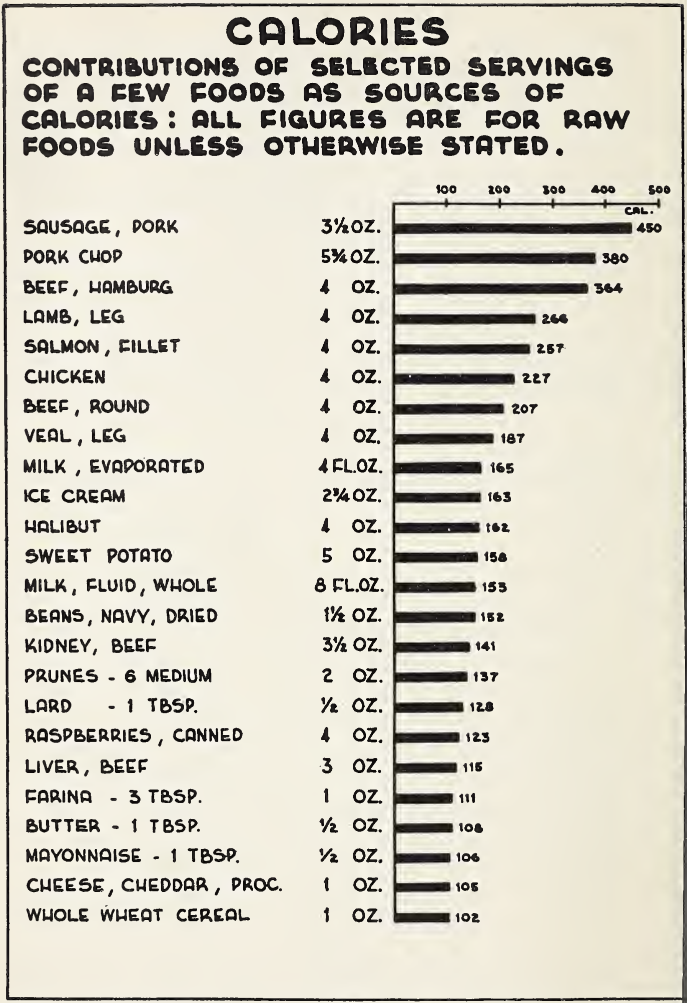
Foods are analysed in the chemical laboratory. The accuracy of the results, of course, depends on the samples obtained, as well as the skill of the technician. Since the sample from one area may differ from that taken from another, and also since there is variation from season to season and year to year, food tables of necessity give average values. These average values are very useful, but it should be remembered that they are not absolute values. There is not likely to be very much difference in the values assigned to the protein, fat and carbohydrate content of foods when analysed in different laboratories and at different times, but analyses of mineral matter and vitamins may show great variation depending on methods used and samples chosen.

In Appendix 6, p. 166, will be found values based on "Table of Food Values Recommended for Use in Canada". These tables are not complete by any means since most of the analyses have been done on uncooked food. However, there are some figures for cooked foods, and more will be added as more data are assembled.

Heat Value of Foods

We depend on the laboratory to give us the chemical composition of foods, but to find the calorie (heat) value, we also need to know the heat value of proteins, fats and carbohydrates found in these foods. (The calorie is that amount of heat required to raise 1 Kg. water 1°C.) By using a very delicate and precise instrument, called a bomb calorimeter, scientists have been able to state the amount of heat given off by a gram of pure carbohydrate, a gram of pure fat, and a gram of pure protein, when burned in a bomb calorimeter. These figures are higher than the amount obtained when the same food is burned inside the body, since the food loses some calorie value, (1) through incomplete digestion, and (2) through incomplete oxidation in the body. The values for different kinds of pure protein, fat and carbohydrate vary somewhat, and the percentage digested and utilized is also variable.

If a person eats an ordinary mixed diet similar to the Canadian pattern, the physiological fuel values for protein, fat and carbohydrate may be taken as 4, 9, 4 respectively. If, however, the food pattern is different, the above figures would not be accurate. More specific data related to different classes of food would be more in order. This is discussed in detail in "Energy Yielding Components of Food and Computation of Calorie Values" prepared by the



(Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare Ottawa)

FIGURE 3. CALORIES

Nutrition Division of the Food and Agriculture Organization of United Nations. The factors contained in this report were used in computing the calorie values in the Canadian tables.

Functions of Food

The functions of food are threefold. They must supply heat and energy to the body, they must be able to build and repair tissue, and o regulate body processes. Some foods are capable of all three unctions, but many are useful mainly as energy or heat producers. The following table will show the functions of the six classes into which the nutrients have been grouped:

TABLE 2. FUNCTIONS OF THE 6 CLASSES

— Protein
(1) Heat and Energy — Fat
— Carbohydrate

— Protein
(2) Build and Repair — Mineral Matter
— Vitamins

— Mineral Matter
(3) Regulatory — Vitamins
— Water

Heat and Energy

Proteins. Although proteins give heat and energy, they are of pecial importance as building material and will be discussed in a ater chapter with the other building materials.

Fats. Fats may be either liquid or solid. They are composed of wo parts: (1) glycerol and (2) fatty acids which are usually combined as one molecule of glycerol with three molecules of fatty acids. During digestion, fat is broken down into these parts, and hen they are recombined in the minute finger-like processes lining he small intestine, called "villi", to form body fat. The blood then carries this body fat to various parts of the body where it is stored.

TABLE 3. CALORIE VALUES OF SOME COMMON FOODS

FOOD	ONE SERVING	CALORIES
Almonds	½ ounce	90
Apples, fresh, A.P.	1 medium	60
Asparagus, fresh, green	4-5 stalks, 5″ long	20
Bacon, side, cooked	4 strips, 3¼″ long	80
Bananas, fresh	1 medium	90
Beans, baked, canned	¾ cup	185
Beans, fresh, green	½ c. cooked	35
Beef, hamburg	¼ pound	350
Beef, rump, cooked	3½″ x 2½″ x ½″	375
Beets, canned	½ c. diced, cooked	35
Blueberries, fresh	⅔ cup	45
Bread, whole wheat or white	1 slice (1 oz.)	72
Butter	2 tbsp. (1 oz.)	216
Buttermilk or skim milk	1 cup	85
Cabbage, young green	½-¾ cup raw	15
Cake plain, no icing	3″ x 2″ x 1½″ (2 oz.)	180
Carrots, fresh	½ c. cooked	35
Cheese, cheddar	1-inch cube (1 oz.)	112
Chicken, roast	½ breast or 1 thigh	200
Chocolate bar, plain milk	small bar (1½ oz.)	225
Chocolate fudge	1 piece (1 oz.)	100
Chocolate milk	1 c. (8 oz.)	178
Corn, sweet, yellow, niblets	½ cup	85
Eggs, whole	1 medium	72
Figs, dried raw	4 medium	120
Grapefruit, A.P.	½, 4″ diameter	44
Halibut, fresh	4″ x 1¾″ x ¾″	160
Ham, cured, boiled	1 slice, 4½″ x 4½″ x ⅛″	152
Lettuce, head	¼ of 4″ head	10
Milk, fresh whole	1 c. (8 oz.)	154
Oats, rolled	¾ c. cooked (¼ c. uncooked)	100
Onions, young green	4, 5″ long	35
Oranges, fresh	1, 2½″ diameter	44
Orange juice	½ c.	50
Peanut butter	1 tbsp. (½ oz.)	80
Pie, apple	⅛ of pie, 9″ diameter	246
Pork chop, loin	1 large chop ½″ thick	290
Potato, white, mashed	½ c.	100
Radishes	3, 1″ diameter	6
Salmon, canned	½ c. flaked	175
Strawberries, fresh	⅔ c.	36
Sugar, granulated	1 tbsp.	50
Tomato, raw	1, 2½″ diameter	20
Turnips	½ c. cooked	35

NOTE: These values are based on "Table of Food Values Recommended fo Use in Canada". All decimals are omitted.

There are some fatty acids that have a special value. Linoleic cid and linolenic acid are two that have particular nutritional alue and there may be others.

However, it would seem that there is danger in eating too much at since it seems to be related to the formation of cholesterol, a atty substance found chiefly in the bile but also in other parts of he body. Apparently a high level of cholesterol in the blood serum s associated with atherosclerosis, a type of hardening and thickening of the walls of the arteries, so perhaps it would be well for older persons to restrict their intake of fat somewhat. Dr. Mayer states:

"Differences between national fat intakes are considerable. In nany areas of the world, such as large parts of Africa and the Far East, fats account for only 8-10% of total calories. The U.S. epresents the other extreme with somewhat over 40%. Spain, Portugal, Italy, consume on the average 20% of their calories as at; France and Britain are in the 30-35% range; Canada reaches 37%. Keys has utilized these differences to demonstrate the correlaion between dietary fat level and serum cholesterol.

"The first comparison was between 'clinically healthy' men in he cities of Minneapolis-St. Paul, Minn., and of Naples, Italy. These groups consumed respectively 40 and 20 per cent of their alories as fat. Keys found that serum cholesterol levels were imilar in both groups in the 18 to 35 years range. However above 35, there was a progressively increasing difference; the serum holesterol of the Minnesotans showed a steady upward trend while hat of the Italians remained constant. Incidentally, average weights nd incidence of obesity were the same in both groups. Furthermore, here was no correlation between weights and serum cholesterol in ither group."

Carbohydrates. Carbohydrates are composed of starches and ugars. These two make up the larger part of the food of man and re the cheapest food in the Canadian dietary. They are easily digested, and in fact all carbohydrates are broken down to simple ugars eventually by digestion. The commonest sugar is glucose which irculates in the blood and is sometimes called "blood sugar". Since ll carbohydrates become simple sugars, there is often more sugar bsorbed from the digestive tract than the blood needs or than can be used for energy. The excess is built up into a complex form called glycogen and stored in the liver and muscles. As the blood sugar is used up there is a constant supply ready from the glycogen which breaks down easily into simple sugar.

EXERCISE

Estimate the calorie value of the food you ate yesterday. Use Appendix 6.

REFERENCES

FAO, Nutrition Division. Energy Yielding Components of Food and Computation of Calorie Values. 1947.

Mayer, J. Nutrition and Civilization. *J. Can. Diet. Assoc.* 16, 13-21. 1954.

Table of Food Values Recommended for Use in Canada. 1951.

Chapter 3.

CALORIE REQUIREMENTS

The total calorie requirements of an individual may be divided into two parts for the purpose of discussion.

(1) Calories are required to enable the body to do the work involved in the beating of the heart, in breathing, in the activity of the glands and to keep the muscles in a normal state of tension. This involuntary work is necessary to life itself and continues for twenty-four hours every day and so on throughout life. It remains reasonably constant over long periods of time and is called the basal metabolic rate (BMR).

(2) The variable part of the total calorie requirement is that due to the activity of the individual. It will vary considerably according to the type of work done. The housewife needs more calories to do her work than the stenographer who sits at her desk most of the day. The schoolgirl who enjoys skating or badminton uses up more calories in these activities than the girl who dislikes sports of all kinds and spends her leisure hours reading.

1. Basal Metabolic Rate (BMR)

The basal metabolic rate of an adult is so constant in health that any real variation from normal is looked on as a sign of poor health. The normal rate has been found by using a machine such as the one in Figure 4. Many thousands of tests have been made on healthy people and from these data a table of figures has been prepared to act as a guide. The normal is called 100% and since there is individual variation any figure that is + or — 15% of this normal is considered within the range of what might be expected in health.

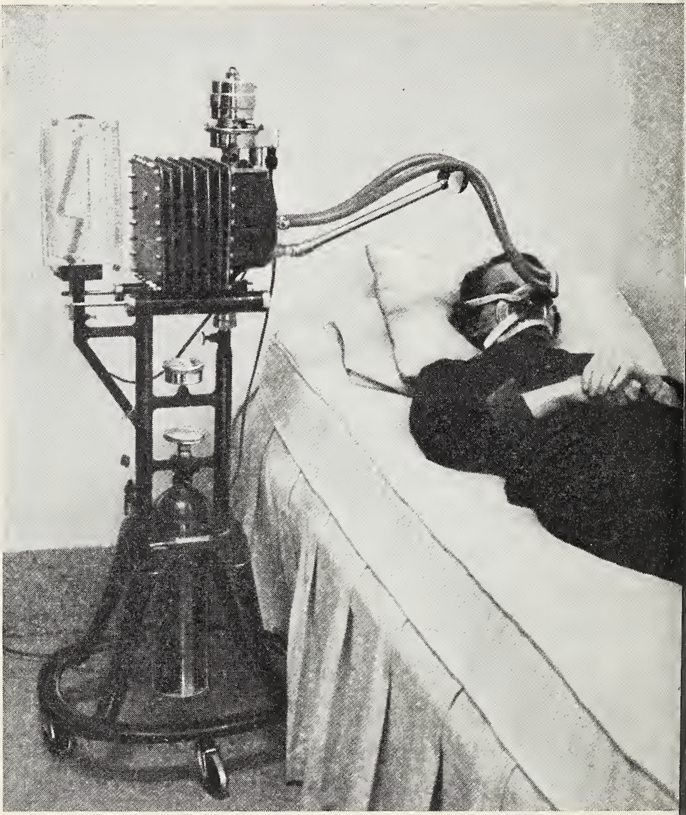


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FIGURE 4. RESPIRATION APPARATUS FOR MEASURIN THE BASAL METABOLIC RATE

This apparatus measures the amount of oxygen used up by th individual at rest. Since oxygen is used by the body in order to d any work, either voluntary or involuntary, the amount consume during the test is an indirect measure of the involuntary work don vhile lying down at rest. In other words, it is a measure of the asal metabolic rate. The calorie value of oxygen is known so it is asy to change the amount of oxygen into calories consumed at this ime.

When an individual has a test taken with a machine similar to he one in Figure 4, it is an actual test taken at a certain time under xact conditions. It is not necessary nor is it always possible to ake actual basal tests of everyone. However the predicted basal for nyone can be found by using a formula which is based on many ctual tests. One such predicted formula has been worked out by leiber. He uses the weight of the person expressed in kilograms nd a constant figure. His formula is: $70\ (W_{Kg.}^{3/4})$.

Using the above formula, the predicted basal metabolic rates for verage men and women are:

Average woman,
weighing 55 kilograms (121 lb.) $= 70(55^{3/4}) =$ 1400 calories

Average man,
weighing 65 kilograms (143 lb.) $= 70(65^{3/4}) =$ 1600 calories

ther formulas have been suggested by different research workers, ut Kleiber's formula is the one used in Canada.

BMR of Juveniles. The basal metabolic rate of juveniles is nuch higher than that of adults per unit of weight. This is due to he stimulus of growth and different body composition. The BMR highest per pound of body weight at about 1 year and then drops omewhat with slight variations until the individual stops growing. hen the formula for adults may be used.

2. Voluntary Activity

Calories required for voluntary activity will vary according to he occupation of the individual, whether it is sedentary, moderate r heavy. The term "maintenance" is associated with an inactive existence as described by Orr and Leitch. It is the minimum calori need of an unemployed adult man which they estimate as 45 calories. This is about ⅓ more than basal requirements.

BASAL FORMULA	MAINTENANCE FORMULA
$70\ (W_{Kg.}^{3/4})$	$93\ (W_{Kg.}^{3/4})$

In Table 4 will be found Canadian standards for calori expenditures for adults doing different kinds of work.

TABLE 4. CALORIE EXPENDITURE (Adults)

INDIVIDUAL	TYPE OF WORK	TOTAL DAILY EXPENDITURE	BMR	ACTIVIT ONLY
Average man 65 kilograms (143 lb.)	"Maintenance"	2050	1600	450
	Sedentary	2325	1600	725
	Moderate	2850	1600	1250
	Heavy	3600	1600	2000
	Very heavy	4600	1600	3000
Average woman 55 kilograms (121 lb.)	Sedentary	2125	1400	725
	Moderate	2400	1400	1000
	Heavy	2900	1400	1500

These are very similar to the calorie requirements of th "reference man" and "reference woman" as described in the FA bulletin "Calorie Requirements" and used as a basis in considerin world food needs.

For juveniles it is not possible to separate out the calories require for growth, basal metabolic rate and various activities. Table shows Canadian standards for calorie expenditure and FA standards for "reference" children.

TABLE 5. CALORIE EXPENDITURE (Juveniles)

CATEGORY	AGES (years)	AV. WEIGHT LB.	CALORIES (Canadian)	FAO "REFERENCE" CHILDREN
children	1 - 2 - 3	26	1200	1200
	4 - 5 - 6	40	1600	1600
	7 - 8 - 9	55	2000	2000
	10 - 11 - 12	75	2400	2500
boys	13 - 14 - 15	100	2850	3200
girls	13 - 14 - 15	100	2500	2600

The calories spent on an activity will vary greatly depending on he skill of the individual. Many more calories will be spent by one who is learning a technique than by one who is already skilled.

Underweight and Overweight

Although as can be seen by the first chapter, average Canadians at a wide variety of foods, and the total quantity seems adequate, et we know there are problems of both underweight and overweight among the population. It is important to keep one's weight easonably close to an estimated ideal. Insurance companies tell us hat a "good risk" is a person who is neither too thin nor too heavy, and a "poor risk" is the reverse.

All food, after it enters the blood stream, must either be burned or heat and energy, or stored as body fat. It follows that the overweight person eats more food than he burns up for his work, and so eposits it as body fat, thereby gaining weight. The underweight person eats less food than he needs for his daily work and play, and o he uses up his store of fat from his body to meet his needs. The nly way he can gain is by eating more, sleeping more and xercising less.

Simple Underweight. Since the underweight person does not at enough total calories for his needs, it is important to find out he reasons and try to correct them. One important reason may be that insufficient food is eaten at breakfast. It is difficult to ea enough total calories during the day to make up for a poor breakfast or no breakfast at all. Perhaps it is a case of getting up too lat to take time to eat a good breakfast and gradually a poor habit i established. Possibly it is a lack of appetite. To stimulate a appetite drink a glass of orange juice on rising.

When the appetite is stimulated, it should not be difficult to ea a little more food than formerly and then a gain in weight follows If the underweight person has never eaten a good breakfast, change here may be all that is necessary. Here is a good breakfast

A GOOD BREAKFAST

Citrus fruit
Whole-grain cereal with milk
Bread with butter or margarine
Eggs or other protein food (if desired)
Beverage—milk for children

The importance of a good breakfast can hardly be over-estimate However, extra food at other meals will also be a help in increasin total daily calories. Since the capacity of the stomach is limited, i would probably be useful to restrict liquids at meal-time or at lea until a good meal is eaten. Clear soup taken at meal-time fills th stomach with food that has low calorie value and leaves too littl room for the foods that have a greater calorie value.

Simple Overweight. The difficulty here is that too much foo is eaten and not enough exercise taken to use it up. The appetit is too good! Sometimes it is due to an injury which means enforce idleness while the appetite remains normal. The extra food whic would usually be burned up in exercise is now deposited as bod fat. In other cases the individual seems naturally to have too lar an appetite for his own good and so it is difficult to regulate th amount eaten. However, if there is a real desire to reduce, it ca be managed by a strict adherence to a diet which includes only th ood groups listed in Canada's Food Rules. Some slight changes in mounts would perhaps make it more appetizing and at the same ime allow for greater variation in the menus. For example, an ncrease in the amount of fruits and vegetables would be helpful, .g., increase the amount of fruit to 3 servings instead of 2 and add ne extra serving of vegetable. This increase in calories could be ounterbalanced by reducing the amount of bread to two slices nstead of four, and the butter (or margarine) to one tablespoon nstead of two. Salad dressing is probably necessary to make the alads attractive. Table 6 shows these changes.

ABLE 6. CALORIE CHANGES

ADD	CALORIES	SUBTRACT	CALORIES
1 large apple	75	2 slices bread	150
½ serving carrots	17	1 tbsp. butter	108
1 tbsp. French dressing	59		——
	——	Total	258
Total	151		— 151
			——
		Decrease in calories	= 107

The increase in fruit allows for fresh or stewed fruit or fruit uice at every meal and the extra vegetable allows for salads every lay. The difference in calories may be greater or less than 100, lepending on the choice of fruit and vegetable.

No sugar should be added to any food and no extra fat used in he preparation of the food. The milk used could be skim milk nstead of whole milk if plenty of green- and yellow-coloured egetables are used.

The total calories for the day with the alterations suggested ould be about 1,400-1,600 calories. This is approximately the MR requirements of an average adolescent. Since the estimated otal daily requirements are much higher, the fat stored in the body will be used up to meet the need. If this menu pattern is adhere to faithfully for at least 3 months, there should be a loss in weigh of 3-4 lb. monthly. It would be unwise to cut calories any mor since the period of growth is not over. Too great a drop in weigh is not desirable at any time. Of course the regular activity shoul continue as usual. Even walking to school and home again will us up some calories. If growth has ceased, the amount of milk can b reduced to 2c. Otherwise, the choice of food remains the same.

Here is a menu pattern for a reducing diet with a sample men based on it.

MENU PATTERN	SAMPLE MENU*
BREAKFAST	BREAKFAST
Fruit or fruit juice	Orange juice
Cereal with milk	Rolled oats Skim milk
Bread or toast with	Whole-wheat toast (1) Butter
Butter or margarine	Skim milk
Skim milk	
LUNCH	LUNCH
Protein dish, e.g. eggs, cheese or meat	Poached eggs (2)
Raw vegetable	Whole-wheat toast (1) Butter
Fruit, fresh or stewed	Cabbage salad
Bread with margarine or butter	French dressing
Skim milk	Canned apricots
	Skim milk
DINNER	DINNER
Meat, fish or poultry	Broiled steak
Potatoes	Potatoes Carrots
Cooked vegetables (one green or yellow)	Broccoli
Fruit	Apple
Skim milk	Skim milk

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*An analysis of this sample menu is shown in Table 7.

NUTRIENTS

		MINERAL MATTER				VITAMINS					SCORE
Food	*Amt.*	*Calories*	*Protein* gm.	*Calcium* gm.	*Iron* mg.	*Vit. A* I.U.	*Thiamine* mg.	*Riboflavin* mg.	*Niacin* mg.	*Ascorbic Acid* mg.	
Milk, skim	4 c.	336	33	1.16	.8	trace	.36	1.68	.8	?	20
Orange juice	½ c.	64	0	.012	.4	120	.08	.02	.2	50	
Apricots, canned	6 halves and juice	80	0	.01	.3	1350	.02	.02	.3	?	20
Apple, large	1	76	0	.008	.4	120	.05	.04	.3	?	
Potato	1 sm. serv.	83	2	.011	.7	20	.11	.04	1.2	?	
Broccoli	1 serv.	27	3	.104	1.0	2800	.08	.17	.9	?	20
Carrot sticks, raw	½ serv.	17	0	.019	.4	6000	.03	.03	.2	?	
Cabbage, raw	1 serv.	13	0	.023	.2	40	.03	.02	.2	25	
(French salad dressing)	1 tbsp.	59	0	0	0	0	0	0	0	0	
Rolled oats (cooked)	¾ c.	98	4	.013	1.1	0	.18	.04	.2	0	
Bread (2 sl. whole wh.)	2 slices	144	6	.03	1.4	0	.10	.06	2.0	0	20
Butter or margarine	1 tbsp.	108	0	0	0	500	0	0	0	0	
Beef, round, E.P.	1 serv.	207	22	.012	3.3	0	.09	.19	5.3	0	
Eggs	2	144	12	.048	2.4	1020	.08	.26	trace	0	20
Totals		1456	82	1.5	12.4	11970	1.21	2.55	11.6	75	100
Standard adolescent girl		2500	75	1.5	12.0	3300	.75	1.25	7.5	30	100
Difference		1044	7	....	.4	7670	.46	1.30	4.1	50	......

NOTE: 1. The question mark (?) found in the table means that there is some of the nutrient present but it is variable depending on the season of the year and the method of cooking.

2. A change in the foods chosen to represent fruits and vegetables would alter the nutrients present a little but not to any great extent.

3. Since the calorie value of a pound of body fat is approximately 3,000 calories, a diet similar to the one above would mean a loss in weight of about 1½ lbs. weekly. This is, of course, on the understanding that bodily activity remains constant and that the requirement is 2,500 calories daily.

Since, when reducing, it is desirable to keep the intake of calories no higher than BMR, it is important to choose foods that give building materials, e.g., protein, mineral matter and vitamins, as well as calories. Unless this point is kept in mind, the needs of the body for protein, calcium and vitamin A, to mention only a few, will not be met. Look at the abbreviated table below which shows some comparisons in nutritive value.

TABLE 8. SOME NUTRITIVE COMPARISONS

FOOD	AMT.	CALORIES	PROTEIN gm.	CALCIUM gm.	VITAMIN A I. U.
Milk, whole	1 glass (6 oz.)	114	6	.2	285
Milk, skim	1 glass (6 oz.)	63	6	.2	0
Carbonated beverages	1 glass (6 oz.)	84	0	0	0
Chocolate creams	2	102	0	0	0

It is easily seen that milk is much more valuable than carbonate drinks or candy. It also shows that the important differenc between skim milk and whole milk is in the vitamin A content o whole milk. An increase in the green and yellow vegetables wil give the needed vitamin A. See the chapter on vitamin A.

Food Exchange Groups

In Appendix 5 will be found foods grouped into six differen sections. Each section contains foods that are so much alike i chemical composition that they can be exchanged for each othe without changing the calorie value to any great extent. Thes groups are based on the nutritive value of a common unit as see in the table below and are very useful in planning a reducing diet.

ABLE 9. FOOD EXCHANGE GROUPS

		PROXIMATE COMPOSITION			
Group	*Unit*	*Protein*	*Fat*	*Carbohydrate*	*Calories*
1	1 c. milk	8	10	12	160
2	(a) vegetable with little or no food value				—
	(b) ½ c. veg.	2	—	7	35
3	1 slice bread	3	—	15	75
4	1 orange	—	—	10	40
5	1 egg	7	5	—	75
6	1 tsp. fat	—	5	—	45

If there are excessive deviations from the normal weight, a hysician should be asked to prescribe. There may be physical ifficulties which either prevent a gain, e.g., diseased tonsils, or ause an increase in weight, e.g., abnormal thyroid condition.

EXERCISES

. Using the menu pattern on p. 22 write out five different daily enus using as many different foods as possible. Make these menus ttractive in colour and appearance. Appendix 5 should be helpful.

. Work out the predicted basal metabolic rate of an adult weighing 0 kilograms, using the Canadian formula.

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Chapter 4.

PROTEINS

Although protein has calorie value and can be burned in the body to give heat and energy, its prime function is to build new tissues and repair old ones. Its ability to do this depends on its amino acid content. There are twenty amino acids but not all of them are of equal importance, nor are they all found in every protein.

Foods called "protein foods" are: meat, fish, chicken, milk cheese, eggs, legumes and nuts. The proteins in these foods have special names, such as casein and lactalbumin in milk; myosin and albumin in meat; excelsin in nuts, and many others. Each protein in turn contains varying amounts of the twenty amino acids.

Essential Amino Acids (EAA)

Some amino acids can be made by the human body if the materials are present. Others can never be manufactured by the body but must be contained in the food as eaten. These are called essential amino acids. Table 10 gives a list of all the amino acids essential or otherwise.

As well as the eight listed below as being essential for adults, there are two others, namely, arginine and histidine, which may be necessary for growth even if they are not necessary for mere maintenance Cystine, another amino acid which is not considered essential, i still useful as it will replace ⅙ methionine requirement; tyrosin also is useful since it will replace ½ the phenylalanine requirement The amino acid, tryptophan, is a provitamin as well and can turn into niacin, which belongs to the B-family of vitamins. So these five amino acids deserve special consideration although they ar not "essential" in the usually accepted meaning of the term.

TABLE 10.

ESSENTIAL AMINO ACIDS FOR ADULTS	OTHER AMINO ACIDS
1. Isoleucine	1. Alanine
2. Leucine	2. Arginine
3. Lysine	3. Aspartic Acid
4. Methionine	4. Citrulline
5. Phenylalanine	5. Cystine
6. Threonine	6. Glutamic Acid
7. Tryptophan	7. Glycine
8. Valine	8. Histidine
	9. Hydroxyproline
	10. Proline
	11. Serine
	12. Tyrosine

Not only must the essential amino acids be present in the proteins eaten, but they must be present in large enough amounts and at the same time, if best results are to be obtained. Some proteins may be deficient in only one essential amino acid and so, by using another protein that contains the missing amino acid along with it, the deficiency is made up.

Protein cannot be synthesized if one essential amino acid is lacking, even if all other necessary amino acids are present in liberal amounts. It must have that particular amino acid in sufficient amounts to allow the work of building to go on.

Cereals are relatively low in lysine so bread will not build body protein without the help of some food, eaten with it, that contains sufficient lysine to make up for the lack in bread. Fortunately, foods like milk, cheese and meat contain liberal amounts of lysine and so when combinations like bread and cheese or bread and meat are eaten there is no lack of lysine. Rolled oats also is low in lysine, so the combination of rolled oats with milk, which is served for breakfast in so many Canadian homes, gives a nutritionally adequate food. The "limiting factor", lysine, has been supplied by the right combination of porridge and milk.

TABLE 11. CONTENT OF ESSENTIAL AMINO ACIDS IN SOME PROTEINS AND FOODS*

(percentages)

(USDA Miscellaneous Publication No. 696. 1950)

MATERIAL	N	ISOLEUCINE	LEUCINE	LYSINE	METHIONINE	PHENYLALANINE	THREONINE	TRYPTOPHAN	VALINE
Proteins									
Casein	16.07	5.63	9.22	8.20	2.58	4.89	4.80	1.20	6.90
Gelatin	18.32	1.25	3.30	4.44	.78	2.33	2.10	.044	2.90
Ovalbumin	15.98	7.41	9.43	6.32	4.43	7.17	4.48	1.30	7.54
Ox muscle protein	16.00	6.50	9.37	10.00	2.75	4.58	5.80	1.30	5.85
Phaseolin (Navy bean)	16.07	6.69	10.50	7.20	1.12	8.04	4.16	.50	6.00
Zein (corn)	16.00	5.03	21.10	.21	1.41	7.30	2.62	.026	3.98
Foods									
Egg, whole dried	8.11	4.43	6.37	4.00	1.39	3.71	3.00	.87	3.55
Milk, dry skim	6.57	2.51	4.24	2.91	.89	1.82	2.15	.46	2.84
Oatmeal	2.73	.76	1.32	.51	.18	.79	.62	.18	.9
Soybean flour	8.85	2.71	4.16	3.97	.55	2.63	2.53	.62	2.72
Wheat, whole	3.07	.69	1.13	.48	.19	.78	.57	.16	.79
Yeast, dried	7.71	2.37	3.25	3.50	.53	1.79	2.54	.45	2.54

*Moisture- and ash-free basis

NOTE: To compare the amino acid content of proteins and foods the figure 16 for N should be used.

In Table 11 will be found a list of a few proteins and some foods with their content of the eight essential amino acids expressed as percentages.

Rat Experiments

A great deal has been learned about proteins and their effect on growth through experimental work with rats. Since the albino rat eats the same food as a man and thrives in captivity, it is an ideal animal for laboratory experiments related to the food of man. The results of good or bad food habits will show up very quickly, since the rat is an adult in 3 months and by 3 years has lived to a ripe old age equivalent to 90 years in man. This "speeding up" of the growth process means that in a few weeks' time results of special diets can be obtained. In Appendix 4 will be found some suggestions for carrying on simple feeding experiments in the classroom.

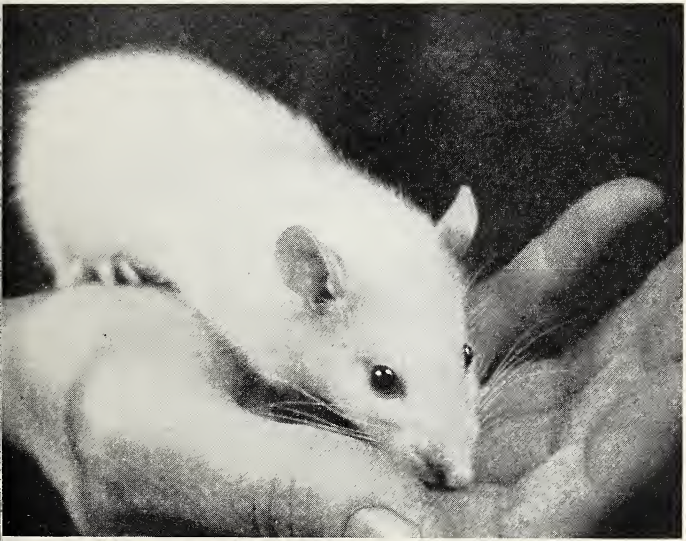

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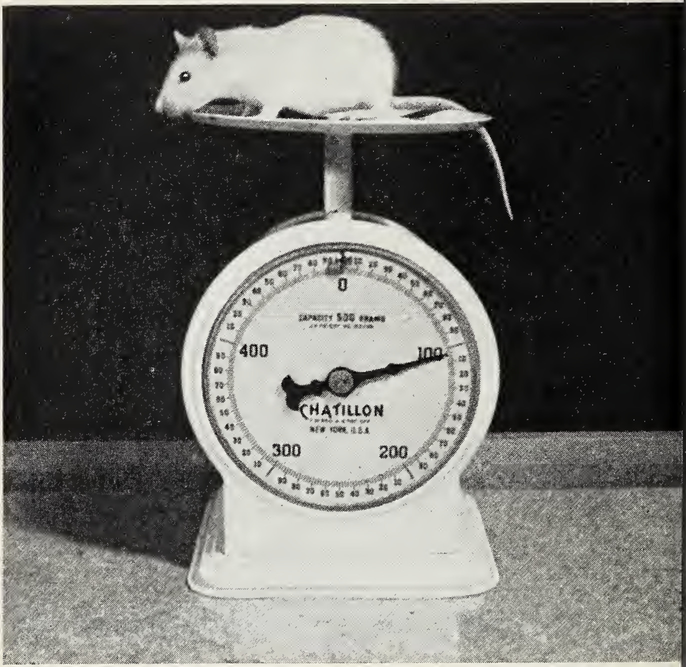
FIGURE 5. A NORMAL HEALTHY RAT

A. Held in the hand.



University of Manitoba, 195

B. Standing on the scales for weighing.

One of the simplest experiments is a comparison of a protei containing all the essential amino acids necessary for growth, lik casein or lactalbumin, found in milk, with another protein whic is lacking in some essential amino acids, like gelatin or zein. I Figure 6 will be found two rats who started their experimental lif weighing exactly the same, 50 grams. One rat was given casein a the protein in his diet, and the other was given gelatin as th protein. In 3 weeks the casein rat had doubled his weight while th gelatin rat was still about the same weight as when the experimen was started.

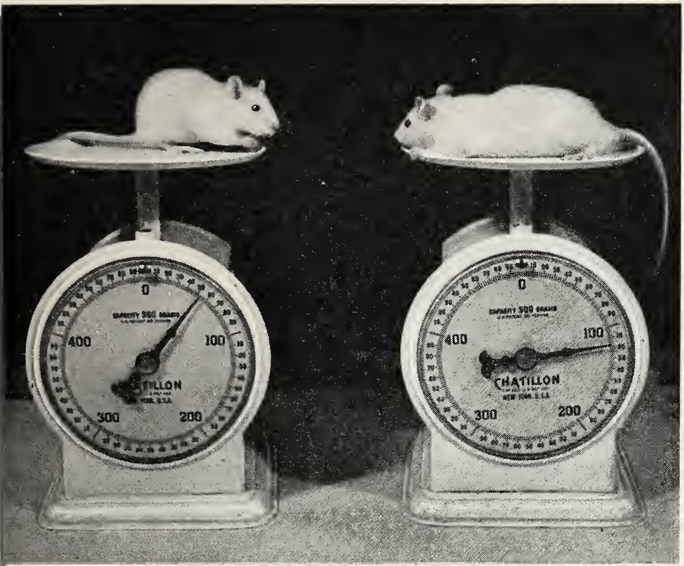


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FIGURE 6. COMPARISON OF GROWTH ON CASEIN AND GELATIN DIETS

Dr. Cannon of Chicago University has devised a "Rat-Repletion Method" which is excellent for obtaining quick and accurate results with proteins. His method obtains results even quicker than the ordinary rat growth method. This is described in his book *Recent Advances in Nutrition.*

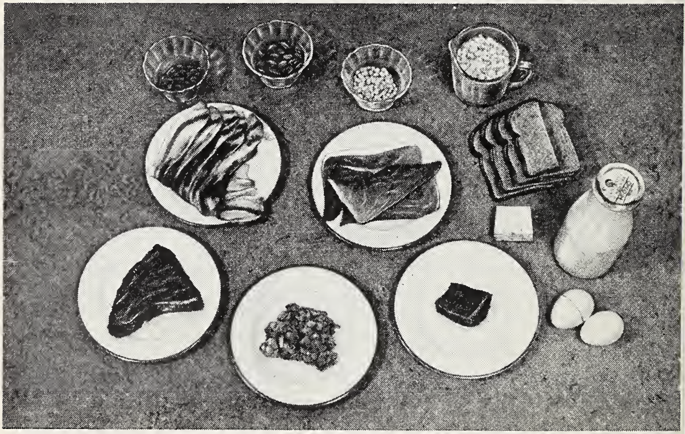
Protein Content of Food

Although stress is laid on the importance of certain amino acids, t should be remembered that in food as eaten there is an abundance of other amino acids as well. If there is an insufficient amount of these other amino acids, the human body can synthesize them so as to have what is necessary for tissue building or repairing.

Foods have been analysed for their protein content over a period of many years. Recently, the individual proteins are being analysed for their amino acid content. Table 11 shows some analyses done by chemical and microbiological techniques. A new method which promises to speed up our knowledge of the amino acid content of food is paper-partition chromatography. This is a method of chemical analysis using the principle of chromatography. Strips of filter paper are used to separate the amino acids in a mixture, instead of a solid column. Only a few milligrams are needed for analysis.

Although it is interesting to know the percentages of protein in food and the amino acids in proteins, it is more necessary from a practical point of view to know how much protein is in the food we eat. In Figure 7 are shown the amounts of different foods required to give 10 grams of protein.

FIGURE 7. PROTEIN EQUIVALENTS (10 grams protein)



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Peanuts (1½ oz.)
Almonds (⅓ c.)
Navy beans (¼ c. uncooked)
Rolled oats, uncooked (¾ c.)

Bacon) (¼ lb.)
Ham (2 thin slices)
Whole-wheat bread (3½ slices)
Cheese (1½ oz.)
Milk (½ pt.)

Liver (2 oz.)
Salmon (¼ c.)
Beefsteak (½ serving)
Eggs (1½)

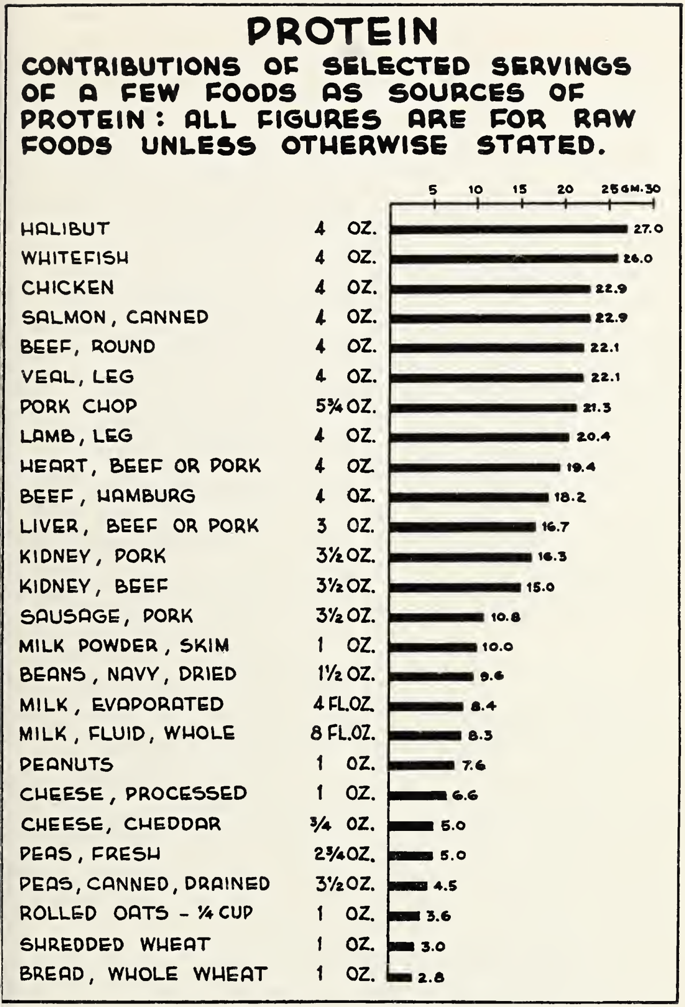


FIGURE 8. PROTEIN

(Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare, Ottawa)

Each food shown above contains 10 grams of protein. In other words, each individual food is equivalent to any one of the other foods in the amount of its protein content. The calorie value will be quite different, as will be the amount of other nutrients contained. One-half pint of milk contains the same amount of protein as 1½ eggs or 5 slices of side bacon. (Back bacon contains more protein than side bacon.) A small cube of cheese contains as much protein as two thin slices of ham, etc.

It will be noticed that many foods contain some protein, but animal foods contain a higher percentage than do most foods. Nuts and legumes, such as dried peas and beans, are high in protein, while fresh vegetables and fruits contain practically no protein. Although the actual percentage of protein in milk is low, the large amount commonly used makes it an excellent daily source of protein. Cereals also contain a fair amount of protein (approximately 9%-15%) and since Canadians eat one-third of their calories in the form of cereals, they are a very good source of protein in the ordinary Canadian diet. In many countries, cereals are the mainstay of the population for both calories and proteins.

Protein Requirements

A. Adults need protein to replace the amount lost from the body. These losses are classified under the following headings:

1. Protein Loss. To make up for the loss of protein from the body tissues. This loss is constant due to the fact that nitrogen from worn-out cells is excreted daily. This is proved by many nitrogen (N) balance experiments. (Since most proteins contain approximately 16% nitrogen, the common method of changing the nitrogen found in excreta to protein is N x 6.25.)

2. Imperfect Digestion. The loss in digestion due to imperfect digestion and the loss of nitrogen found in digestive juices which are excreted from the body.

3. Imperfect Biological Value. The loss due to the fact that all the essential amino acids are not always present in the right amounts t the right moment for the needs of the body. This has been alled "imperfect biological value" and may be very high, depending on food habits.

Using the facts stated above, the following formula for adults has een evolved and is used in Canada:

$$\text{Dietary Protein}_{\text{gm.}} = 2.75\ W_{\text{Kg.}}^{3/4}$$

When worked out, this formula comes to approximately 1 gram of protein per kilogram of body weight. The need does not vary ccording to activity but remains reasonably constant in an adult whose weight remains constant. The average woman (55 kilograms) eeds 55 grams of protein daily, and the average man (65 kilograms) needs 65 grams of protein daily. There is no increase in the eed for protein by the average woman when she is working hard, lthough she is likely to eat more total food and so increase her ctual intake of protein.

The Canadian food pattern is such that about 10-15% of total alories eaten are in the form of protein. This means that the ctual intake of protein varies greatly and is usually in excess of he standard set forth in the formula above.

In the United Kingdom, the food pattern is similar to the anadian, and they consider all protein needs are adequately overed by their food habits as long as the calorie intake is sufficient. In the United States (NRC 1953) the standard is similar o the Canadian.

Protein requirement during pregnancy and lactation will be discussed in a later chapter.

. Juveniles:

4. Growth. To the three reasons listed above should be added, or juveniles, the most important of all—growth needs. This will ary according to age. The following table used in Canadian tandards is based on survey data in which normal growth was the riterion.

TABLE 12. PROTEIN FOR GROWTH

(Within age groups the larger allowance applies to the younger child)

AGE GROUP	PROTEIN PER KILOGRAM	PROTEIN PER LB.
Infants—to end of 2nd year	4.0-3.5	1.8-1.6
Children 2 - 3 - 4	3.0-2.5	1.3-1.1
5 - 15	2.0-1.5	0.9-0.7

Although at the present time the Canadian standard for protei for adults is 1 gram protein per kilogram body weight, it is possibl that in the future the standard will be described in terms of essentia amino acids (EAA). Already much work has been done on man' requirement, in terms of amino acids. Foremost among the investigators is Dr. W. C. Rose of the University of Illinois, who, afte years of research work on the protein requirement of college men has stated the minimum and recommended intakes for normal ma when the diet furnishes sufficient nitrogen for the synthesis of non-essentials. This is given in Table 13. The recommended intake i twice the minimum requirement.

TABLE 13. MINIMUM AND RECOMMENDED INTAKES FO NORMAL MAN WHEN DIET FURNISHES SUFFICIENT FOR SYNTHESIS OF NON-ESSENTIALS

(Rose) (Federation Proceedings 8,546. 1949.)

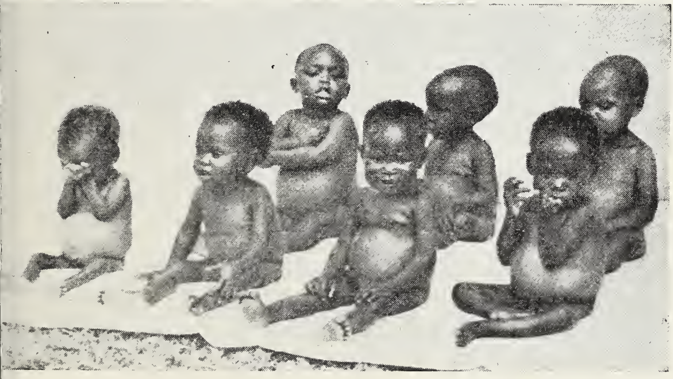
AMINO ACID	MINIMUM DAILY REQUIREMENT (gr.)	RECOMMENDED DAILY INTAKE (gr.)	SUBJECT TREATE
L—tryptophan	0.25	0.5	31
L—phenylalanine	1.10	2.2	22
L—lysine	0.80	1.6	27
L—threonine	0.50	1.0	19
L—valine	0.80	1.6	23
L—methionine	1.10	2.2	13
L—leucine	1.10	2.2	8
L—isoleucine	0.70	1.4	8

Animal *vs.* Vegetable Protein

It is becoming more and more apparent that the effective use of rotein in the diet depends on the essential amino acids present and ot whether it is animal or vegetable protein. The chances are that nore of the essential amino acids, and in larger amounts, are found n animal proteins than in vegetable proteins. For this reason, it is asier to cover one's requirements of EAA by using animal protein r animal protein supplemented by vegetable protein than by egetable protein alone.

Large amounts of animal protein apparently do no harm since ve are told that the Eskimos, who live almost wholly on meat and at, eat over 200 grams of protein daily and remain remarkably ealthy and vigorous.

Although man can live on less protein than the Canadian tandard, too little protein in the diet has a disastrous result. The isease kwashiorkor, found in Africa and in Central America, is aused mainly by a deficiency of proteins of high biological value. t is found in small children who have existed for some time on a iet that contained no animal protein and very small amounts of

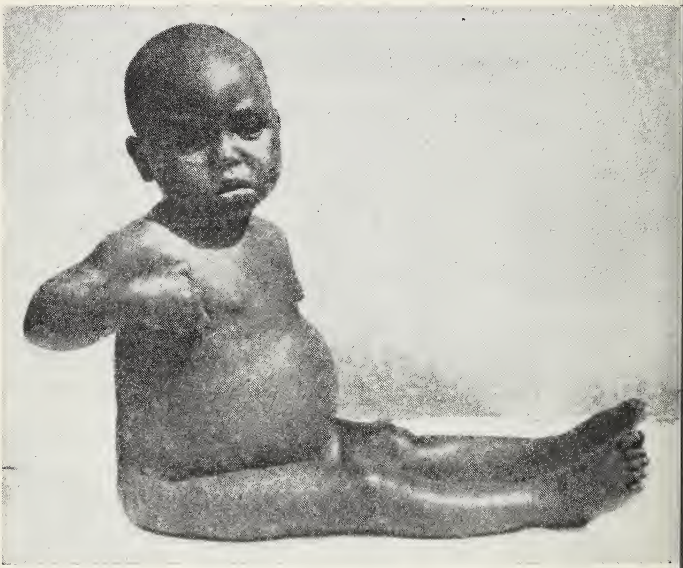


Courtesy Government of Kenya

FIGURE 9. GROUP OF KWASHIORKOR CASES

vegetable protein mostly in the form of cassava (a form of tapioca) and plantains. It can be cured by giving skim-milk powder.

Typical symptoms of kwashiorkor are: pot-belly, oedema, altered hair texture, dyspigmentation of hair and miserable expression. The mortality is high if not treated in time. In the bulletin "Kwashiorkor in Africa" the statement is made that in Johannesburg an Pretoria the mortality was between 30% and 40% until recently. I some centres it went up to 90% or even higher. Since the introduction of skim milk the mortality has fallen very rapidly in Sout Africa and was recently reported in Durban to be 2.8%, exclusiv of cases dying in the first 24 hours.



Courtesy Government of Keny

FIGURE 10. KWASHIORKOR CASE SHOWING POT-BELLY, OEDEMA OF LEGS AND DERMATOSIS OF THIGH

Since it is not always possible to obtain animal milk, attempts are eing made to work out a suitable "vegetable milk" made from soy ean suitably supplemented with cereals.

EXERCISES

. Study Table 7. List the foods that contain no protein. What food roup contains very little protein?

. List foods you ate yesterday and work out the approximate protein ontent, using Appendix 6. Do not use decimals.

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Chapter 5.

MINERAL MATTER

Although there are 14 minerals found in the body and traces o some others, there are only 6 that are important enough to warran study. These are calcium and phosphorus, iron and copper, iodin and fluorine. It is possible that in the future it may be important t study some or all of the others intensely, but at the present time w believe that it is not necessary. The others: potassium, sulphu sodium, chlorine, magnesium, manganese, cobalt, and zinc, ar found in liberal amounts in normal food and water, and so it seem they are no problem in normal human nutrition.

A. Calcium and Phosphorus

Calcium and phosphorus are found together as calcium pho phate, mostly in the bones with small amounts in blood and so tissues. It is believed today that even the hard bones of the bod slowly break down and are built up again out of the materials foun in the food. Although the main function of calcium and phosphor is to build the bony framework of the body and the teeth, sma amounts are important in other ways. Calcium is important to th normal clotting of the blood and normal osmotic pressure,* whi phosphorus forms part of such compounds as phospholipins an phosphoproteins as well as helping with normal osmotic pressure.

Absorption of Calcium and Phosphorus. No nutrient is of u in building body tissues unless it is absorbed and taken by the bloo to various parts of the body. In the case of calcium and phosphor this is of special significance, since there is a tendency to for insoluble compounds, such as calcium oxalate, which cannot bsorbed and which pass through the digestive tract unchanged. To e absorbed these minerals must be in a soluble form and preferably cid in reaction. Since the stomach contents are acid, a certain egree of acidity still remains in the duodenum and absorption takes lace there for the most part. This acidity gradually disappears and o there is little absorption farther down the digestive tract. Some eople who have too little acid in the stomach juices may lose a arge part of the calcium in the food eaten due to this fact. Even hen conditions are favourable, a great deal of calcium in the food s not absorbed. Dr. Holmes states that in a research project on 11 ubjects, only 20% of the calcium in milk was absorbed.

---

*The force with which a solution enclosed in semi-permeab membrane attracts water.

Calcium and Phosphorus Requirements.

1. Adults:

There is a great difference of opinion regarding the normal equirement of man for calcium.

Through their work on rats, Henry and Kon, of the University of eading (1953), proved that old rats accustomed to do with little alcium remain in calcium equilibrium in circumstances leading to alcium loss in rats used to a higher intake. It appears that not nly the extent of calcium stores but the way in which these stores ere accumulated is highly important in calcium metabolism.

There have been some post-mortem studies by Walker and rvidsson (1954) of the chemical composition of ribs of South frican Bantus, habituated to a diet low in calcium. These studies em to show that the level of calcium intake, within limits, does not ffect the percentage composition of bone.

Again, a group of research workers from Harvard Medical chool working in Peru in 1952, stated that the average estimated lcium requirement to maintain calcium balance in 10 men was etween .1 and .2 grams calcium daily. Evidence was presented to ow that maintenance requirement is related to calcium reserves.

In a calcium balance experiment on nineteen subjects over a eriod of five years Steggerda and Mitchell, of the University of linois, reported wide differences in requirements of individuals.

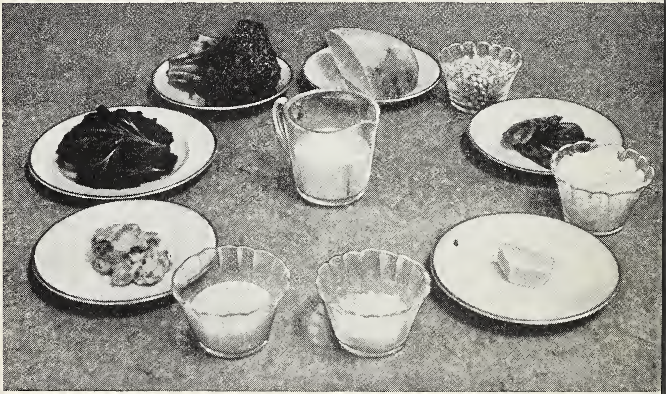
They suggest 9.21 mg. (10 mg.) calcium per kilogram per day a the amount necessary for calcium equilibrium.

With such great differences in the results of research work don in various parts of the world, only tentative standards can be us until there is a clarification of the subject.

The Canadian standard at present (1955) is 10 milligrams pe kilogram per day for adults:

e.g.—Average woman
55 kilograms (121 lb.) requires .55 grams Ca. daily.
Average man
65 kilograms (143 lb.) requires .65 grams Ca. daily.

FIGURE 11. ½ CUP MILK EQUIVALENTS IN CALCIUM
(0.14 grams calcium)



University of Manitoba, 19

Broccoli (⅓ lb.)
Turnip (¾ lb.)
Navy beans, raw (2 servings)
Figs (4 large)
Chard (1½ servings)
Milk, fluid (½ c.)
Cottage chees (½ c.)
Salmon, canned (⅓ c.)
Milk, evaporated (¼ c.)
Milk, dried (2 tbsp.)
Cheese, cheddar (⅔ oz.)

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*Requirements during pregnancy and lactation will be discussed a later chapter.

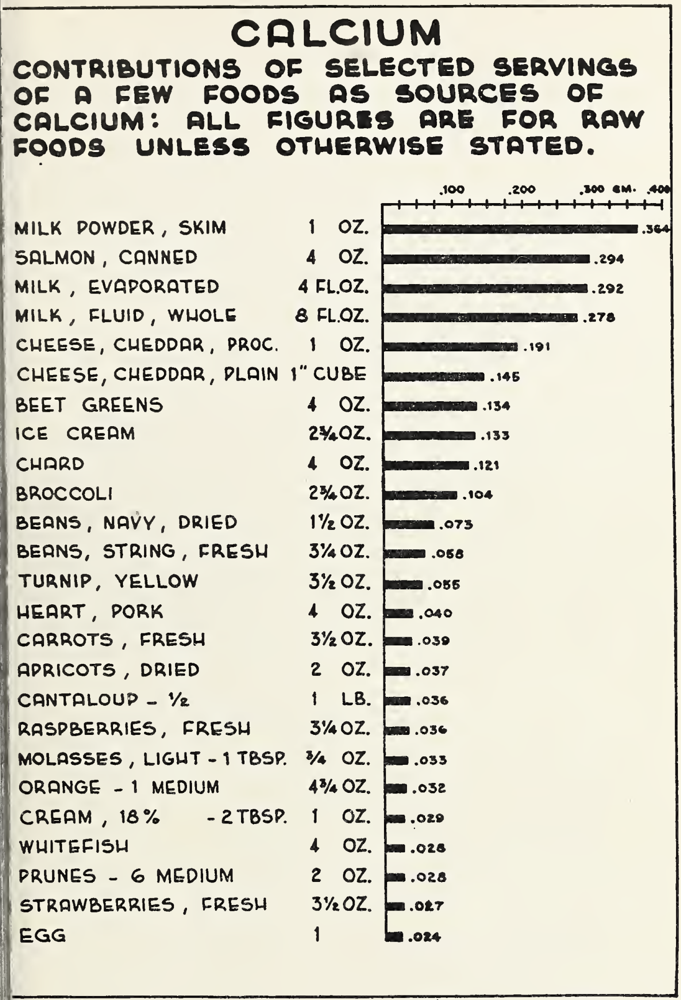


FIGURE 12. CALCIUM

Iealthful Eating, 1952. Nutrition Division, Department of National Health and Welfare, Ottawa)

The recommended allowance of the National Research Council of the United States (1953) is .8 grams calcium daily regardless of size.

2. Juveniles:

Children (birth to 12 years)	1.0 gram daily
Adolescents (13-14-15 years)	1.5 gram daily

This is more liberal than the American allowance, although there is not much difference.

The phosphorus requirements are the same as the calcium requirements.

Calcium in Food. As will be seen by looking at Figures 11 and 12, the important source of calcium is milk. In each case in Figure 11, the amount of food shown contains as much calcium as ½ cup milk. When milk is processed, it does not lose its calcium and so both evaporated milk and dried milk are excellent sources. So is ordinary cheddar cheese or processed cheese, but cottage cheese has lost some calcium in its manufacture. Canned salmon is a good source of calcium because of the bones it contains. Greens like broccoli and chard are fair sources of calcium.

B. Iron and Copper

The amount of iron in the body is small. It has been estimated as being from 3-5 grams, depending on size and age. A little over half is found in the haemoglobin of the red cells; about a third is storage iron found in liver, spleen, red bone marrow and kidneys; and the rest is found in small amounts in muscles, serum and iron-containing enzymes. Iron is of great importance to the body since it is responsible for the oxygen-carrying properties of the haemoglobin of the red cells of the blood and the oxygen-using power of the enzymes that contain iron.

The ferrous form of iron is the form most readily absorbed. The amount absorbed varies greatly and is now supposed to be regulated by ferritin (a storage form of iron) and is dependent on the need of he body for more iron. If iron has been lost from the body ecause of a haemorrhage, then iron in the food eaten will be bsorbed more quickly to make up for this loss. Since 1953 bread old in Canada may contain in one pound "not less than 8.0 milli- rams and not more than 12.5 milligrams of iron".

Iron that is stored is used up very slowly and is only withdrawn rom storage depots when the red bone marrow needs more iron to ebuild new red cells. The food iron (labile iron) is presumably sed up first to replace any loss of iron. The ordinary daily loss of ron is very slight since the iron in the broken-down red cells is arried to the bone marrow to be used over again. There are small sses, however, through perspiration, and the kidneys.

Iron Requirement. There are two methods of studying iron equirement.

1. **Balance Experiments.** This is a study of the iron eaten and he iron excreted in an attempt to discover how much was absorbed y the body. Leverton used this method with four college girls as bjects. Her conclusion was that 6.5 milligrams of iron daily was mple for all needs. She emphasized the need for a well-rounded iet.

2. **Use of Radio-active Iron.** In this method radio-active iron used so that its progress through the body can be studied. After -21 days, almost all the radio-active iron is in the red cells and a mple can be withdrawn and analysed.

This method was followed by Darby and his co-workers working ith school children, who estimated that 2.3-3.8 milligrams for hildren 7-9 years old is the mean daily requirement of absorbable on.

The Canadian standard for iron is set forth in Table 14.

Iron in Food. As will be seen by looking at Figures 13 and 14, e best sources of iron are the meats and meat alternates. In this roup the variety meats hold first place. There are appreciable mounts in leafy, green vegetables, in dried fruits, in nuts, and in

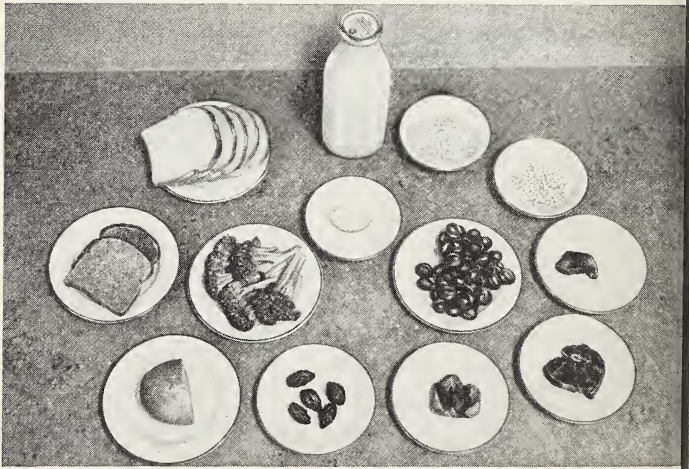
TABLE 14. IRON REQUIREMENTS FOR ADULTS AND CHILDREN

CATEGORY	AGE	IRON IN MILLIGRAMS
Ave. woman*		12
Ave. man		6
Children	1 - 12	6
Boys and girls	13 - adults	12

*Needs for pregnancy and lactation will be discussed later.

These figures are similar to the recommended allowances of the National Research Council of the United States (1953).

FIGURE 13. 1 EGG EQUIVALENTS IN IRON (1.2 mg.)



University of Manitoba, 195

White bread (not enriched) (5 slices)
Milk (1 qt.)
Rolled oats, uncooked (1 serving)
Egg (1)
Navy beans, raw (½ serving)
Whole-wheat bread (2 slices)
Broccoli (2 servings)
Grapes, Malaga (2 med. bunches)
Liver, beef (⅕ serving)
Potato (2 servings)
Prunes (5)
Figs (2 large)
Beefsteak (½ serving)

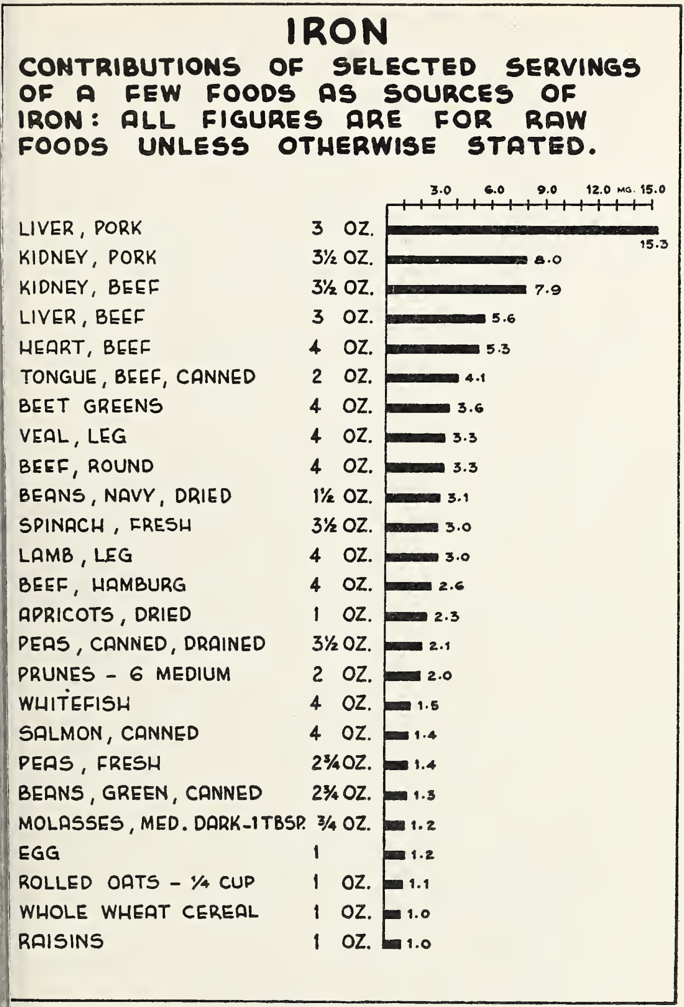


FIGURE 14. IRON

Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare, Ottawa) whole grains. Although pure fats and sugars contain no iron, th less refined molasses contains a fair amount. The amount in mil is very small—it takes a quart of milk to be the equivalent of 1 eg in iron—but apparently its iron is used very efficiently, perha because of its high calcium content. Whole-wheat bread contai about 3 times as much iron as white bread which has not had ir added. The enriched bread which is sold in Canada has had ir added to make it the equivalent of whole-wheat bread in its ir content.

Copper is needed for proper utilization of iron but in such sm amounts that ordinary diets contain sufficient for normal needs.

Blood Donors

The Canadian Red Cross has made an appeal to all Canadia to help save lives by donating blood for its "blood bank". T response has been generous all across Canada and has arous interest in the standards used by the Red Cross in choosing perso suitable to be blood donors. The amount of haemoglobin in t blood is the criterion. A simple test is used to determine the amou of haemoglobin (Hb.) found in a sample of blood taken from potential blood donor. The blood must contain over 80% (12 grams Hb.) of an optimum 15.6 grams per 100 c.c. if the individu is to be accepted by the Red Cross. From 78% - 82% is consider border-line and these persons are rejected. The interval betwe donations is usually 4-6 months although men may be taken 3 months' time. They prefer to have women return only twice year. The age range is 18-65 years. The volume of blood given made up very rapidly, only a few hours being necessary to replace The formed elements in the blood, however, are regenerated mu more slowly.

When there is loss of blood through donation to the Red Cr or through a haemorrhage of any kind, iron alone is insufficient make up for the loss. Not only iron, but protein as well, and perha vitamins such as B_{12}, pyridoxine, niacin and ascorbic acid, may required. In other words, there is need for food that will supply he nutrients and not just iron. A well-rounded diet containing iberal supplies of the foods suggested in Canada's Food Rules is he one best able to make good the loss sustained.

C. Iodine and Fluorine

Iodine

Iodine is found in minute amounts in the body—approximately 5 milligrams in the adult. Of this amount 15 milligrams is concenrated in the thyroid gland while the rest is found in the blood and ther tissues of the body. The thyroid makes good use of iodine, naking thyroxine with some of it and storing amounts not needed lsewhere.

Thyroxine, the active form of iodine, is released into the blood in mounts necessary to regulate the oxygen-consuming function of e body. When a basal metabolic rate (BMR) test, p. 16 which easures the oxygen consumed by an individual, is taken, it also easures the thyroxine-forming ability of the thyroid gland which gain depends on its supply of iodine.

Since the basal metabolic rate is directly dependent on the supply f thyroxine (iodine) any method of evaluating the iodine content f the thyroid gland is of value.

Radio-active Iodine

A new method using radio-active iodine has been developed ecently to find out the iodine content of the thyroid. The individual given radio-active iodine one morning and 24 hours later returns see how much has been absorbed by the gland. If the thyroid as a poor supply of iodine it will pick up more radio-active iodine an would the normal gland and if it has a rich supply, it will pick p less. The amount picked up is calculated by using a Geiger unter. This is an expensive test and has not yet supplanted the der test in determining the normalcy of the thyroid gland.

Variations in the Thyroid Gland

When the thyroid gland does not receive the correct amount of dine, it does not function properly. If there is insufficient iodine

during the adolescent period, it will show as a simple colloid goitr
If there is a lack during fetal life, the baby is born with a lack an
is called a cretin. If there is destruction of the thyroid gland in a
adult, the condition is called myxoedema. Sometimes the gland i
overactive and becomes toxic.

Simple Goitre. This is the commonest form of goitre and i
caused by a lessening of iodine in the colloid and an increase in th
size and number of cells. This enlargement is an effort to mak
more adequate amounts of thyroxine. This kind of goitre does n
show any toxic symptoms, although it may mean slight underfun
tioning of the gland. Medically, it is important since it may develo
later into a serious condition.

Cretinism. A cretin is a child who has had insufficient thyroxi
during fetal life and has been dwarfed physically and mentally as
result. Unless treated, these cretin dwarfs do not develop normal
and show a low basal metabolic rate. If thyroxine is given to the
early enough, there may be complete recovery. Cretinism can
prevented by giving the mother sufficient iodine during pregnancy

Myxoedema. When anything happens to destroy the cells of t
thyroid gland so that there is a lack of thyroxine, a condition call
myxoedema results. The symptoms are mental sluggishness, increa
in weight, low basal metabolic rate, as well as brittle hair a
thickening of the skin. Thyroid extract effects a great change a
in three months' time the individual is normal again.

Hyperthyroidism. This is a toxic goitre. The symptoms are gre
loss of weight, irritability, rapid pulse, very high basal metabo
rate and extreme nervousness. Suitable treatment by a physician
necessary.

Iodine in Food

The amount of iodine in food is extremely variable. Sea fo
such as oysters, salmon and sea weeds contain fairly large amoun
Analysis of drinking-water shows variable amounts and the amou
in plants depends on whether there is iodine in the soil or not.

Since there is no uniform source of supply in food, in Canada it is added directly to the salt. Since 1949 the Canadian law reads:

"No person shall sell salt or free-running salt for table or general household use unless such salt contains 0.01 percent of potassium iodide."

This public health measure will lessen considerably the cases of goitre in this country.

Fluorine

Fluorine appears naturally in the water supply in some communties in Canada. It is associated in these communities with a great reduction in dental decay. For this reason, it will be discussed later n Chapter 12 which is concerned with methods for combating dental caries.

EXERCISES

. List all the milk and cheese you ate yesterday whether cooked or uncooked. Find the calcium content, using Appendix 6.

. List the meat, fruits and vegetables you ate yesterday and find the ron content, using Appendix 6.

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hapter 6.

VITAMINS—FAT-SOLUBLE A

Vitamin History

The history of the development of vitamin research makes fascin-ting reading. However, there are many texts that deal with it in etail, and so this section will be limited to a very sketchy outline.

Nutritional diseases such as scurvy, rickets and beri-beri have een known for centuries. As early as the seventeenth century it was nown that scurvy was caused by a lack of fresh food in the diet. n 1804 it was eliminated from the Royal Navy and Mercantile arine by giving lime juice or lemon juice to the sailors. Although was definitely proved that food could cure this nutritional disease, was not until much later that purified diets were used in an tempt to find out what was in food that proved so beneficial.

In 1906 Sir Gowland Hopkins used a synthetic diet of purified oteins, fats, carbohydrates and mineral matter in his experiments ith rats. They did not thrive but as soon as he added a little milk e situation was changed. He stated that there was something in ilk not protein, fat, carbohydrate or mineral matter, that was cessary for the life of the rat.

Rapid progress was made and in the United States, McCollum ggested letters of the alphabet—fat-soluble A and water-soluble B as descriptive terms. It was not long before the multiplicity of e members of the vitamin family became evident and they were ouped into two classes: (1) those soluble in fat called fat-soluble amins and (2) those soluble in water called water-soluble vita-ns. At the present time it is more customary to call the fat-soluble amins by letters of the alphabet and the water-soluble vitamins names suggesting their chemical composition. It is probably only matter of time before all vitamins will be named according to ir chemical composition.

Although there are at least eight vitamins known to be necessar for the life of man, the amounts required are very minute. S small, in fact, that if the normal daily requirements of a health adult were totalled, they would weigh less than one-tenth of a gran

The amounts in food are so small that food tables usually stat the amount in milligrams per 100 grams of food. For two vitamin fat-soluble A and fat-soluble D, amounts in food are stated International Units (IU).

Some vitamins are needed by man and not by animals. F instance: ascorbic acid is required by man, but the rat synthesiz what it needs. On the whole though, experimental work wi animals has shed much light on the requirements of man.

Fat-Soluble Vitamins

There are four fat-soluble vitamins:

1. Vitamin A
2. Vitamin D
3. Vitamin E
4. Vitamin K

Properties in Common. These fat-soluble vitamins have so properties in common. They are not soluble in water and they a not destroyed by heat. They can be stored in the liver in lar amounts and form a valuable reserve to be used in time of ne They are absorbed from the intestinal tract with the help of b salts so that any interference with the production of bile salts w cause a lessening in the absorption of fat-soluble vitamins. The u of mineral oil, either in salad dressing or as a laxative, preve some absorption of fat-soluble vitamins too, and so should only used if the physician orders it.

Vitamin A

There are two forms of vitamin A, the animal form and the pl form (carotene). In the final analysis, however, all vitamin comes from a plant source since animals eat plants and make th wn vitamin A from the provitamin or carotene present. Similarly, he vitamin A in fish livers came originally from tiny sea plants. The provitamin or carotene in plants is associated with the green nd yellow pigments. There are four carotenes which are nutri-ionally useful, the most effective being beta-carotene.

Vitamin A is stable to heat and so is not lost during cooking or rocessing. However, it may be destroyed by oxidation or exposure o ultra-violet light, so foods containing A should be stored in a ool, dark place. Rancid fats have lost their vitamin A value.

Results of A Deficiency. The results of a lack of vitamin A have een studied by means of experimental animals. The major ymptoms that developed in animals fed an A-deficient diet were as llows:

1. Cessation of growth.
2. Eye disease. This starts with a dryness of the membrane of the eye which develops into an ulceration and perforation of the cornea.
3. Abnormal growth of bones leading to constriction of the nerves of sight and hearing followed by lessened ability to see and hear.
4. Reproductive failure.

Vitamin A Deficiency in Man

1. Night Blindness. In man, the first deficiency to appear is an npaired dark adaptation or night blindness. This is due to the fact at the eye is continually using up vitamin A in the process of see-g. In the retina of the eye is a substance called visual purple hich is made up of a protein and vitamin A. When sunlight falls this visual purple, it is bleached to visual yellow with a loss of tamin A. There is an immediate renewal of visual purple through e medium of the blood which has a constant supply of vitamin A. the blood does not supply vitamin A quickly enough to make up e lack, the manufacture of visual purple will take place slowly d vision in dim light is impaired. This is night blindness due to vitamin A deficiency and can be cured by giving foods rich in this vitamin.

2. Pathological Dryness and Change in the Skin. When deprived of sufficient A, the skin changes its nature and becomes dry and horny. In the corner of the eye, tiny lumps form called Bitot's spots. If the deficiency is very great over a long period of time, the lids become swollen and sore and the eye disease, xerophthalmia, develops. Cod-liver oil cures this disease rapidly.

Methods of Assaying Foods for Vitamin A

There are various methods for finding out the vitamin A content of food.

1. Bioassay Method. This was the first method used in finding the amount of A in food. It depends upon the growth of the ra under certain specified conditions. This is still used although it i time-consuming. The results are based on gain in weight or change in the epithelium of the vagina.

2. Chemical and Spectrometric Methods. These are in commo use today. Carr and Price have devised a chemical test whereb a stable blue colour is produced when antimony trichloride is adde to vitamin A. This "blue value" can be stated in terms o international units of vitamin A.

Substances rich in vitamin A will absorb ultra-violet rays in th region of 328 millimicrons. There is good agreement between thes two methods.

The International Unit (IU) adopted in 1934 by the League o Nations is 0.6 micrograms (mcg.) of a standard specimen of bet carotene. In 1949 the World Health Organization set up a standar for vitamin A. It represents 0.3 micrograms of vitamin A_1 alcoho

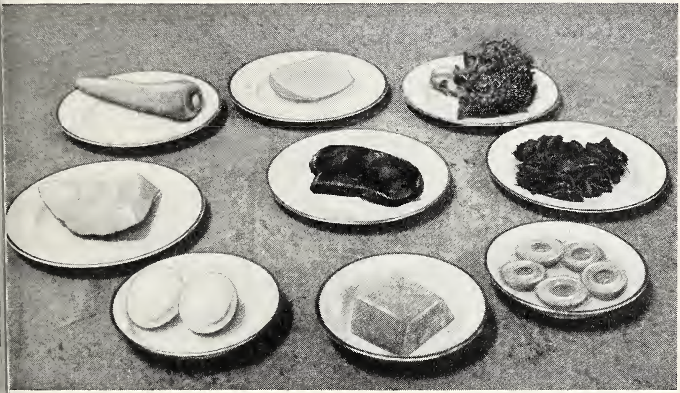
Availability of Carotene

Since carotene is the inactive form of vitamin A, it must b changed to active vitamin A to be useful to the body. Before it can b changed, the food containing it has to be digested and the caroten set free to become active vitamin A. The availability of carotene i foods varies considerably. Experimental evidence shows that in some foods only 24% is available (excretion 76%) while in others 74% is available (excretion 26%).

Vitamin A Content of Food

The richest sources of vitamin A are fish-liver oils and the livers of all animals. The older the animal the greater the storage and

FIGURE 15. FOODS RICH IN VITAMIN A



University of Manitoba, 1955

Carrot (10,560)
Sweet potato (6,620)
Broccoli (2,140)
Squash, winter (3,660)
Liver, beef (43,900)
Spinach, frozen (6,820)
2 Eggs (1,020)
Cheese, cheddar (1,400)
Apricots, canned (1,300)

OTE: These foods all weigh 100 grams (about ¼ lb.). Nearly all of them uld be called an average serving. The number under the name of the food the amount of Vitamin A expressed as IU.

erefore the richer the source. Beef liver is a better source than lf liver. Milk fat contains both vitamin A and its provitamin, rotene, and so does egg yolk. The proportions vary partly due to od eaten by the animal and partly due to breed.

The richest sources of carotene or provitamin A are the green-

and yellow-coloured vegetables. The green and yellow pigments found in plants signify their value. The brighter the colour the richer the source. Thin, green leaves are excellent sources. Since the "availability" of carotene is variable, it is wise to eat some animal form of vitamin A as well as carotene.

The above foods in Figure 15 illustrate the general points brought out in the preceding paragraph. Liver, with its amazing concentration of vitamin A, would provide in one serving sufficient vitamin A to meet the needs of an individual for nearly a week. Those who enjoy liver should plan to eat it once a week. It is not necessary to eat liver, however, in order to have a liberal allowance of A. A large serving of carrots would give several days' supply of A, as would a good serving of sweet potato. Green vegetables like the spinach and broccoli shown above are good sources when eaten liberally. A serving of apricots alone would more than cover one's daily requirement. Margarine, with 16,000 IU of vitamin A per lb., is as good a source as butter and supplies a little vitamin A daily.

It is easily seen that it is a simple matter to obtain the vitamin A necessary for body needs. The rule "one green- or yellow-coloured vegetable daily" should be sufficient to keep an individual healthy. There should be variety in the foods eaten to compensate for the variety in the availability of carotene.

Human Requirement of Vitamin A

There are two methods of measuring the amount of vitamin A needed by the body. These are based on (1) the reaction of th eye to changes in the intensity of light and (2) the amount o vitamin A and carotene found in the blood.

1. Dark Adaptation Test. In this test, a machine, called a adaptometer, is used to measure the minimum amount of ligh necessary to enable an individual to see an object in dim light. If i takes a lot of light before he can see the object, it shows that h eyes do not adapt as readily as do the eyes of an individual wh needs less light.

In making this test, the retina of the eye is bleached by a stron

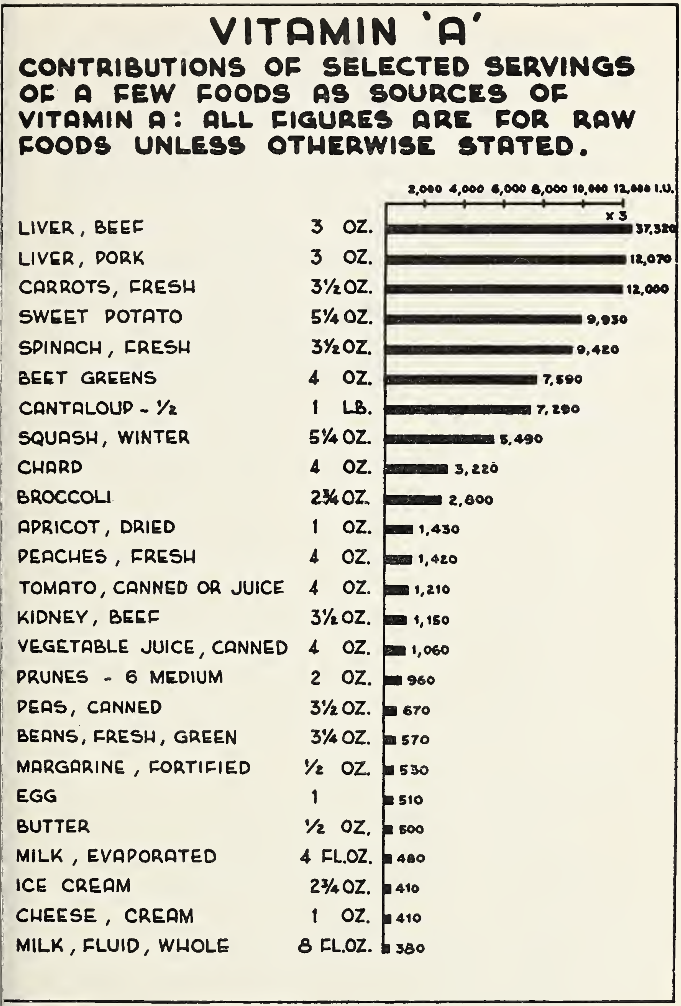


FIGURE 16. VITAMIN A

Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare, Ottawa) light. This bleaching uses up the vitamin A present, so it must be rebuilt. If there is plenty of vitamin A in the blood, the new pigments will be rebuilt in the rods and cones of the retina and the minimum amount of light (threshold) necessary to see an object will be small. If there is insufficient A, the rebuilding takes place slowly and the threshold is high.

A graph in which the threshold brightness is plotted against the time spent in the dark, gives the dark adaptation curve. The light is expressed in logarithms to allow for a great range and yet show it on a small diagram without distorting the picture.

Looking at the figure on the following page, two curves will be seen. They show the dark adaptation of a normal individual (A) before being deprived of vitamin A and (B) after being on an A-deficient diet for 18 months. The change is striking. It took about 100 times more light for dark adaptation after deprivation of vitamin A.

Another method of measuring dark adaptation is rod scotometry. This may prove to be a more sensitive test than the adaptometer.

2. Blood Plasma Levels. Both vitamin A and its precursor, carotene, are found in the blood. The amounts of both vary considerably and it is difficult to state what the normal amount should be. An added difficulty is the fact that the amount in the blood is proportional to the amount in the food eaten. However, an estimate of the average amount in the blood according to the literature on the subject is about 120 IU per 100 ml.

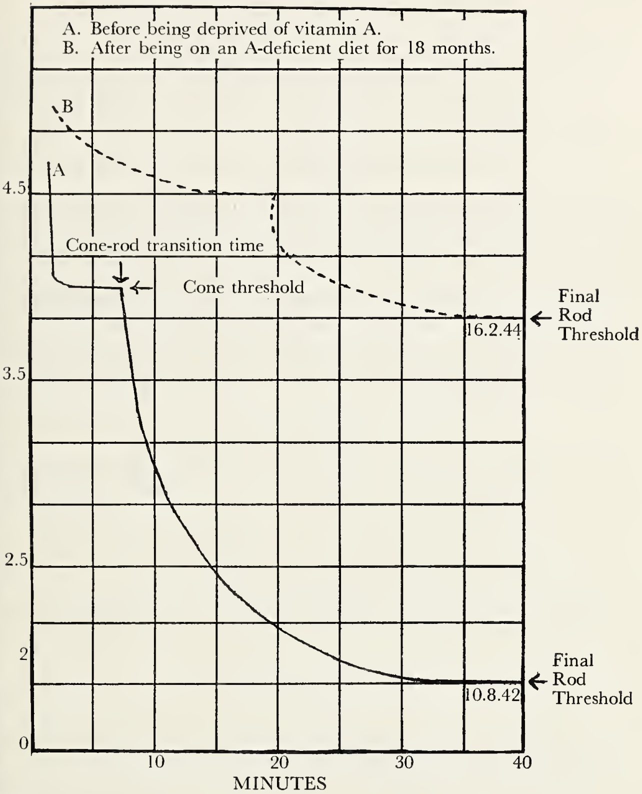
Canadian Standard for Vitamin A

The Canadian standard for vitamin A is based on the amount of preformed vitamin A believed necessary to prevent night blindness or about 4 micrograms per kilogram of body weight. This value has been found applicable to nine different species of mammals.

Since most of our vitamin A comes from the carotenes in the food we eat, and it is only about ¼ as useful as preformed vitamin A, we must multiply the vitamin A requirements by 4 to estimate what is needed daily in the food we eat. This works out to the

FIGURE 17

CURVES OF DARK ADAPTATION SHOWING
CONE THRESHOLD, CONE-ROD TRANSITION TIME
AND FINAL ROD THRESHOLD
(Medical Research Council, S.R. No. 264)



(Courtesy of H.M.S.O. London, England)

In the graph above are two curves which represent the ability of an individual to adapt the eye to dim light before being deprived of vitamin A and after 18 months on a vitamin A deficient diet. The increase in light from less than 2 to almost 4 log. micromillilamberts means that almost 100 times as much light was necessary to see after deprivation of vitamin A than before.

following formula which is used in Canada for both adults an juveniles.

$$\text{Vitamin A}_{\text{IU}} \text{ (from carotene)} = 72\ \text{W}_{\text{Kg.}}$$

Using this formula the vitamin A requirement for:

Average woman
weighing 55 kilograms (121 lb.) is 72 × 55 = 3960 I
Average man
weighing 65 kilograms (143 lb.) is 72 × 65 = 4680 I

In the United States the recommended allowances for adults bot men and women, regardless of size, is 5000 IU. In the Unite Kingdom the amount recommended is 7500 IU for adult me Fortunately vitamin A is stored in the liver and on those days whe more vitamin A is eaten than required, the excess is not wasted, b is ready for use when the food fails to provide what is necessary.

EXERCISES

1. Work out the vitamin A content of the food you ate yesterday, usi Appendix 6. How does it compare with your requirements accordi to the Canadian formula?
2. Plan 7 different combinations of fruits and vegetables that wou be adequate in vitamin A for an adult woman weighing 60 kilogra Use Appendices 5 and 6.
3. Compare margarine with butter from the standpoint of (nutritional value, (2) taste and (3) cost.

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Chapter 7.

FAT-SOLUBLE VITAMINS D, E, K

Vitamin D

The disease, rickets, has been known and recognized for many ears, but it is only during the early part of this century that a cure vas found. We know today that vitamin D will prevent and cure his disease which is easily recognized by bow-legs, pigeon chest and nlarged bones of the forehead.

Vitamin D has many different forms but there are two which are f special importance. One is a provitamin called ergosterol which as a plant source; the other is 7-dehydrocholesterol which has an nimal source. Both these provitamins can be turned into the ctive form by exposing them to ultra-violet light. This is called rradiation.

Sunlight and Vitamin D

It has always been known that children in the tropics who were xposed to the bright sunlight did not develop rickets, but the reason vas not known. The relationship between vitamin D and sunlight s now understood. The animal provitamin, 7-dehydrocholesterol, s found in the skin, and when the bright sunlight reaches the skin, pecial rays of the sun, called ultra-violet, change the 7-dehydro-holesterol to active vitamin D. The blood carries vitamin D to the iver where it is stored for future use.

To be effective the ultra-violet rays must reach the skin, so og, rain and dull weather prevent any beneficial action. Also rdinary glass prevents the penetration of ultra-violet rays. Special lass that will allow ultra-violet rays to penetrate has been made and s used in some green-houses and hospitals.

Action of Vitamin D

The underlying cause of rickets seems to be the inability of th body to absorb calcium and phosphorus in the right proportion from the intestinal tract. There may be plenty of calcium an phosphorus in the food, but without vitamin D there is great loss i the excreta. The amounts absorbed and found in the blood are no in the right proportions, so the bone does not develop normally It is less hard and rigid than it should be, and bends whe there is pressure; or there may be an overgrowth of cartilag instead of bone. Vitamin D corrects this poor proportion of calciu and phosphorus in the blood and bone growth develops normally.

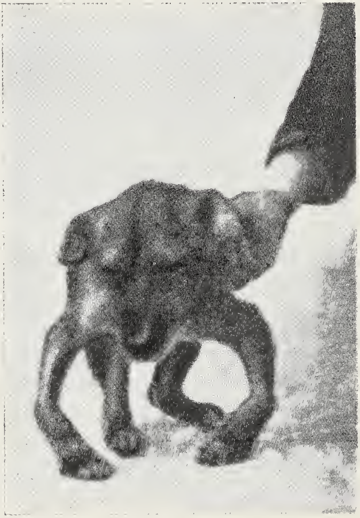


FIGURE 18. DOG WITH RICKETS

Rickets following a diet of 175 c.c. whole milk, white bread ad lib., and 10 c.c linseed oil per diem. Time of experiment, 5½ months. Increase in weigh during period of experiment 2,670 grm.

Medical Research Council No. 38 (revised 1924), courtesy H.M.S.O., London, England

This incorrect proportion of calcium and phosphorus appears ahead of the bony deformities and so an examination of the blood is a very good test if rickets is suspected.

It will be seen from this brief discussion that two things are necessary to prevent rickets: (1) food containing calcium and phosphorus and (2) vitamin D. It is not sufficient to give food alone since a baby fed milk (containing calcium and phosphorus) will develop rickets unless vitamin D is present also. Again, vitamin D alone is not enough since the bone needs calcium and phosphorus for proper development.

Assay for Vitamin D

1. Bioassay. Rats may be used in assaying foods and oils for their vitamin D potency. A common method is the curative method or "line test" devised by McCollum. Rats are made rachitic by giving them a special diet (see Appendix 4) and then they are cured by means of foods or oils containing vitamin D. (Curative dose should be given daily for about 10 days.) The rats are then killed, the radius, i.e., the outer and shorter of the two bones of the forearm, split longitudinally and dipped into silver nitrate. The newly deposited bone shows up as a black line across the enlarged part of the radius. Varying degrees of calcification can be noted by increasing or decreasing the amount of food given. Those rats receiving no vitamin D food act as controls.

2. X-rays. This is also a test of the degree of calcification. In this case the change in the bone is seen in an X-ray picture. This is an expensive method.

The potency of a food is expressed as International Units (IU). One IU = .025 micrograms calciferol (irradiated ergosterol).

Sources of Vitamin D

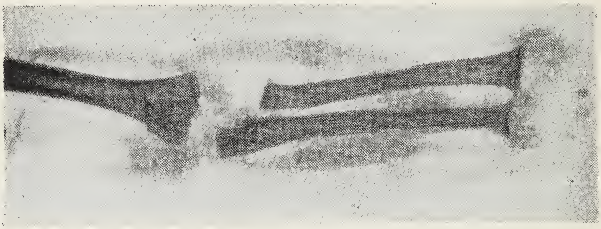
Vitamin D as such may be obtained from fish-liver oils such as cod-liver oil, halibut-liver oil, shark-liver oil, etc. It may also be made by irradiating ergosterol, which is called viosterol or calciferol. Various foods may be irradiated and so become a source of vitamin

FIGURES 19 AND 20. X-RAY PICTURES OF HEALING RICKETS

Courtesy H.M.S.O., London, England

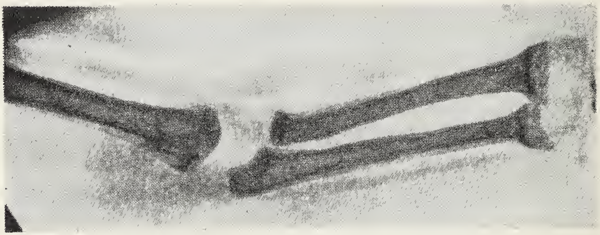
FIG. 19

1



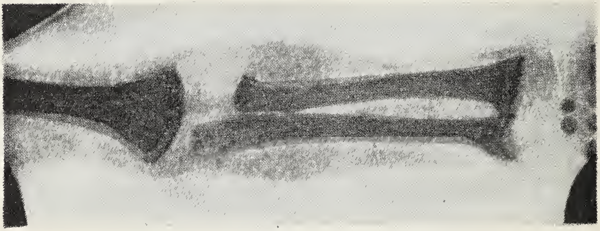
10. III. 22. 10½ m.

2



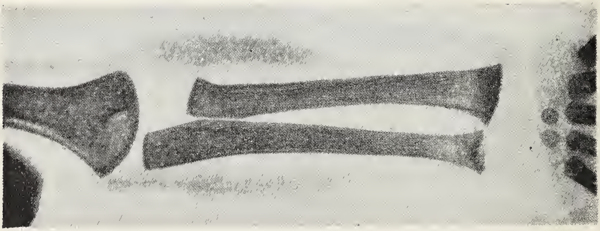
4. IV. 22. 11 m.

3



11. IV. 22. 11 m.

4



15. VI. 22. 14 m.

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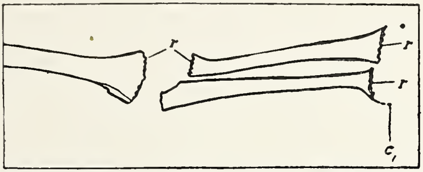
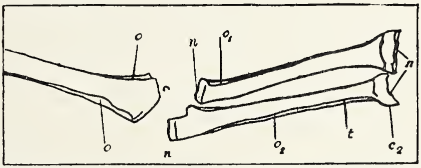
FIG. 20

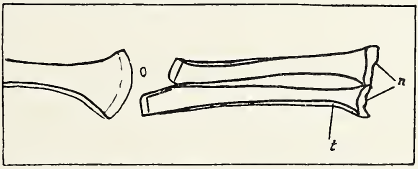
Explanatory drawings for Fig. 19, showing X-ray photographs illustrating severe rickets in a child of ten months and recovery after treatment with cod-liver oil.



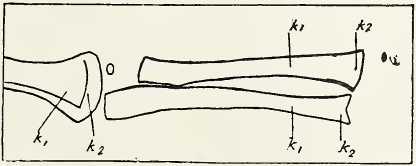
1. (10.3.22.) Florid rickets, no evidence of healing. Osteoporosis present. The structure of the bones is coarse, and the compact bone of the shafts ill-defined and irregular. The metaphyseal margins are frayed (*r*). The distal end of the ulna is slightly cupped, and there is a faint shadow indicating the margin of the expanded, uncalcified zone of osteoid tissue (c_1) which can be detected clinically as an enlargement.



2. (4.4.22.) Healing in progress after 27 days' treatment, showing (1) the deposition of calcium along the shafts of radius (o_1), ulna (o_2), and humerus (*o*); (2) calcium deposition at the metaphyseal margins and in the osteoid zones previously uncalcified and, therefore, scarcely visible (c_2). These areas are bounded on the side towards the epiphysis by irregular lines of shadow which represent the newly formed zone of preparatory calcification (*n*).



3. (11.4.22.) Rapid progress in healing. Note (1) the line of dense calcification at the metaphyseal margins (*n*) corresponding to the new preparatory calcification zone, and (2) the increase in periosteal calcification (osteophyte layer) showing calcified trabeculae (*t*) running at right angles to the long axis of the layer, (3) calcification of the centre of ossification at the distal end of the humerus.



4. (15.6.22.) Healing well advanced after 3 months' treatment. The contour of the shafts is nearly normal, and the coarse structure has become more finely meshed. A band about 0·5 cm. wide of newly formed bone (k_2) is clearly visible at the distal end of the humerus. At the distal end of the radius and ulna the corresponding band is also to be seen. It can be distinguished by its fine homogeneous structure from the portion of the shaft (k_1) formed before the onset of rickets.

D. Since milk contains calcium and phosphorus (necessary to good bone development) irradiation of milk is very natural. This is allowed in Canada. The Canadian law states that evaporated milk may contain up to 480 IU of vitamin D per 15-oz. tin.

There are very few foods that contain vitamin D naturally. Some fish, e.g., herring, mackerel, salmon and sardines, contain a fair amount and egg yolk contains some. Other foods contain none or so little that it is negligible. Because of this lack in ordinary foods it is necessary to give fish-liver oils or concentrates in order to supply vitamin D.

Effect of Vitamin D Deficiency

A lack of vitamin D or sunshine will cause rickets in young children. It is associated with growth, so the most pronounced cases are found in babies who are growing rapidly. It shows itself in slow eruption of teeth, bow-legs, rachitic rosary,* knobby wrists and knees, and narrowed pelvic bones. These bony deformities are ugly but, more important, they may cause trouble later in life. A narrow pelvis may make child-birth difficult or impossible and a contracted chest may predispose to respiratory infections.

Requirement of Vitamin D

The requirements for vitamin D are not known with any accuracy. As far as is known adults need very little, except during pregnancy and lactation. The small amount needed under normal conditions is probably supplied by exposure to bright sunshine. The table below gives the Canadian standard which is based on clinical tests.

TABLE 15. VITAMIN D REQUIREMENTS

Infants (1 and 2 years)	400-800	International Unit
Children (3 to 12 inclusive)	400	" "
Adolescents (13, 14, 15)	400	" "
Women (pregnancy and lactation)	at least 400	" "

---

*A row of beading at the junction of the ribs with their cartilages.

A liver oil is the normal source of vitamin D. Various liver oils and concentrates are found on the market today. Any of them that are plainly marked with the amount of vitamin D present would be satisfactory. Concentrates cost more than the oils.

Prevalence of Rickets

In many parts of Canada one child in every nine shows evidence of having had rickets. This is true notwithstanding the fact that prevention and cure are so simple. There is insufficient sunshine in Canada to prevent rickets in children so it should be standard practice to give them daily some form of liver oil or concentrate.

Vitamin E

Vitamin E was discovered in 1922 by Evans and Bishop. There are four forms known to occur naturally and one form at least is always present in a natural fat. It is an anti-oxidant and is used commercially to prevent oxidation and consequent spoiling of some ood products.

Vitamin E is necessary for reproduction in rats. On an E-deficient diet, the female is unable to bear young and the male becomes terile. In some animals a muscular weakness develops when there s insufficient vitamin E present. In cattle, vitamin E deficiency is ssociated with heart disease.

Since vitamin E has been proved so necessary for animals, it was hought that it might be beneficial in human nutrition. Any treatment along these lines has proved disappointing. Apparently itamin E is found in such liberal amounts in common foods that o one lacks sufficient for normal nutrition.

Vitamin E is found in whole-wheat bread, in wheat germ and in eafy green vegetables. The richest source is an oil made from lants. Margarine, made largely from plant oils, is a very good ource. Milk contains vitamin E in direct proportion to its vitamin A content.

Vitamin E is considered of value in the human diet as it helps in the use of other nutrients.

Vitamin K

Vitamin K was discovered in 1929 by Dam of the University of Copenhagen. He called it the Koagulations-Vitamin because it cured a haemorrhagic disease in chicks which was characterized by a delayed blood-clotting time. This delay was caused by a lack of sufficient prothrombin in the blood and when the chicks were given the Koagulations-Vitamin (vitamin K) the amount of prothrombin returned to normal and the blood showed a normal clotting-time Prothrombin is formed in the liver and does not contain vitamin K but its manufacture is activated by vitamin K.

Sources of Vitamin K

Plants are the best sources of vitamin K. Green leafy vegetables such as spinach and chard contain a lot, while cereals and fruits contain very little. Animal foods are almost lacking in vitamin K It is synthesized in the digestive tract of many animals, including man, so that we are not dependent on food as the sole source of thi vitamin. It requires bile for its absorption, however, and if there i any blocking of the bile ducts, with a consequent inadequate supply of bile to the intestines, there may be poor absorption of vitamin K It is very easy to test for vitamin K by testing the clotting-time o the blood. A delayed clotting-time means insufficient vitamin K The disease haemophilia is an inherited characteristic and cannot b cured by giving vitamin K.

Usefulness of Vitamin K

Under normal circumstances, there is sufficient K in foods eate or synthesized in the intestinal tract, for adequate nutrition. However, in cases of surgery, where the clotting-time of the blood i most important, extra vitamin K may be given to prevent possibl haemorrhage. This is particularly true when there is a stoppage o bile ducts.

New-born infants have little vitamin K and to prevent haemorrhages synthetic vitamin K (menadione) may be given to the mother before delivery or to the infant at birth.

Sometimes clots form in the blood and need to be dissolved. An anti-vitamin K, called dicoumarol, is used in these cases to dissolve the blood clot.

EXERCISE

Write a letter to a mother explaining why she should give her baby cod-liver oil every day.

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Chapter 8.

VITAMINS—WATER-SOLUBLE

The water-soluble vitamins are divided into two parts—vitamin C, or ascorbic acid as it is usually called now, and the vitamin B complex which is composed of many parts, each one being called by its chemical name. All of these vitamins are quite different from each other, but they are grouped together because they will dissolve in water.

Ascorbic Acid (Vitamin C)

Scurvy, like rickets, has been a disease known to man for centuries. Wherever there was a lack of fresh food over a period of time, scurvy would appear. Since sailors, in the days of sailing-vessels, would be without fresh food for months at a time, they developed scurvy, and, in many cases, died of it. There are many interesting and true stories of the dramatic cure when fresh food was given.

When Cartier came to Canada in 1535, many of his men had scurvy, but fortunately the Indians told him how to cure them. They were told to make a spruce tea by steeping the tiny new shoots of the spruce tree. This infusion cured them.

In 1757, Lind described his classic experiment on board the *Salisbury* at sea. He fed 12 patients with scurvy on different substances, including oranges and lemons. The 2 patients who had oranges and lemons made a dramatic recovery—one being back at work in 6 days. His recommendation to the Admiralty that lemon juice or lime juice should be given daily to sailors to prevent scurvy was put into practice in 1804, when a regular issue was made compulsory in the British Navy. The British sailor has been called a "limey" ever since.

Although scurvy could be prevented and cured by food, it was not until the twentieth century that scientists knew the cure was dependent upon a vitamin now called ascorbic acid. It was isolated and synthesized by 1933.

Symptoms of Scurvy

Acute scurvy, which was so common one hundred and fifty years ago, was dreaded particularly by sailors. It showed in swollen gums, n painful joints, and scorbutic spots under the skin. These scorbutic spots were the result of tiny haemorrhages caused by the breaking of the blood-vessel walls. There was loss of weight and great muscular weakness leading to death unless treated.

Today acute scurvy has almost disappeared. Since the cure—resh fruit and vegetables—is so well known and so easy to obtain, t should disappear completely. There are, however, some people, iving on a restricted diet, who may very well be suffering from a mild form of scurvy. Unfortunately, there is some infantile scurvy, which could be prevented so easily. The Children's Hospital in Winnipeg stated that 10% of the babies admitted in the late winter (1954) showed unmistakable signs of scurvy. Other Canadian hospitals also state that they receive scorbutic babies for treatment.

Properties and Action of Ascorbic Acid

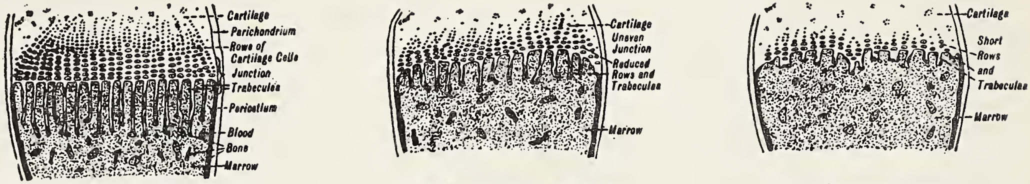
Ascorbic acid is the most unstable of all vitamins. It is easily estroyed by oxidation, which is speeded up by heat and alkali. The rst change in ascorbic acid is the formation of dehydroascorbic acid which can be changed back again to ascorbic acid under favourable conditions. However, dehydroascorbic acid is unstable too and will e destroyed by further oxidation.

Fortunately, an acid medium helps to retain its potency so that uit juice has lost little if any of its value even after processing.

Ascorbic acid is a white, crystalline, odourless substance, comaratively stable in this form.

In some way not clearly understood, ascorbic acid is necessary

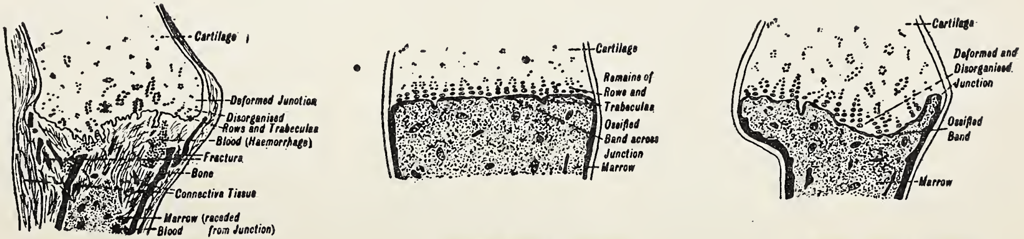
FIGURE 21. EFFECT OF SCURVY ON BONE



i. Normal Rib Junction.

ii. Nearly Normal Rib Junction.
'Incipient Scurvy'.

iii. 'Definite Scurvy'.


Cartilage
Deformed Junction
Disorganised Rows and Trabeculae
Blood (Haemorrhage)
Fractura
Bone
Connective Tissue
Marrow (receded from Junction)
Blood
Cartilage
Remains of Rows and Trabeculae
Ossified Band across Junction
Marrow
Cartilage
Deformed and Disorganised Junction
Ossified Band
Marrow

iv. 'Acute Scurvy'.

v. 'Chronic Scurvy' (definite).

vi. 'Chronic Scurvy' (acute).

Reproduced by permission from the *Biochemical Journal*, 1918, 12, p. 446.
Courtesy H.M.S.O., London, England

or the proper building of intercellular tissue wherever it is found n the body. It is needed for proper bone and tooth formation as hown in Figure 21. When it is absent, blood-vessel walls become ragile and break, causing haemorrhages which show as characterstic scorbutic spots. Wounds do not heal properly without ascorbic cid. Apparently it is necessary in the manufacture of mature ollagen* formed in the normal healing process. Without it the vound will only heal partially and will be likely to break open gain.

Ascorbic acid also aids in the metabolism of tyrosine and phenyllanine, two amino acids. It is thought that the action is associated vith enzymes.

In infectious diseases and fevers such as tuberculosis, there is an ncreased need for ascorbic acid. The old-fashioned hot lemonade s a cure for a cold has scientific approval!

Ascorbic Acid (Vitamin C) Requirement

There have been many scientists working on the fundamental roblem of the daily requirement of ascorbic acid for health. Unlike he fat-soluble vitamins which may be stored in the liver as reserves, he water-soluble vitamins have no great deposits and amounts not sed daily are excreted from the body in the urine. Some ascorbic cid, however, is held in the tissues and symptoms of scurvy only ppear after a deprivation of about 5-6 months.

There are three methods used in estimating the amount of scorbic acid present in the body and in setting up a tentative equirement for health:

(1) Saturation of the tissues;
(2) Blood tests;
(3) Cure of experimental scurvy.

1. Saturation Method (Urinary Excretion). This method is ased on the fact that an excess of ascorbic acid, over what is

---

*A substance present in connective tissue, bone and cartilage. When roperly developed it is called "mature collagen".

TABLE 16. VITAMIN C CONTENT OF PLASMA AND WHITE CELLS IN RELATION TO VITAMIN C INTAKE

VITAMIN C INTAKE ADDITIONAL TO ABOUT 1 MG. IN BASAL DIET (mg. daily)	NO. OF SUBJECTS	DURATION OF DOSE (days)	AVERAGE PLASMA (mg./100ml.)	VITAMIN C CONCENTRATION IN:	
				WHITE CELLS (mg./100g.)	WHOLE BLOOD (mg./100ml.)
0	10	205-269	0.02	1.0	0.05
5	3	125	0.07	2.0	0.06
10	6	101-157	0.03	2.4	0.08
20	5	47-92	0.07	3.4	0.10
50	2	61-66	0.38	9.2	0.41
70	3	300-336	0.69	11.1	0.86
about 600	15	8-11	1.02	17.9	1.13

NOTE: The data refer to average values found towards the end of a period with dose specified in the first column. The figures recorded in the bottom line of the table are the averages of the highest values observed in each of the 15 volunteers at the end of the experiment, when a saturation test was made in which they received a dose of 10 mg. vitamin C per Kg. body weight for 8-11 days. All data were obtained in the fasting state.

(Courtesy of H.M.S.O., London, England)

needed for the tissues, will be excreted in the urine. Consequently, if a large dose is given and a small amount is excreted, it means that a large amount is necessary to saturate the tissues, leaving little to excrete. Conversely, if there is a great deal of the test dose excreted, t means that the tissues are saturated and cannot take up any more.

Using this basic fact, there have been many "saturation tests" made. In some cases excretion over a period of 24 hours is considered while others use only a 4-hour excretion period. The test dose may vary too. Until this test has been standardized and correlated with the ascorbic acid present in the white cells of the blood, results obtained can only be considered tentative.

2. **Blood Tests.** Ascorbic acid is found in the blood both in the plasma and in the white cells. The amount in the plasma appears o depend mainly upon the amount in the food eaten, while the amount in the white cells is dependent upon the amount in the issues. It would seem that further investigations with improvement n techniques would make the amount of ascorbic acid in the white cells a valuable test for estimating tissue stores of ascorbic acid. In Table 16 it will be noted how much more sensitive the white cells are to varying amounts of ascorbic acid than is the plasma.

3. **Cure of Experimental Scurvy.** The most conclusive proof of he amount of ascorbic acid required to prevent and cure scurvy is, of course, to produce scurvy experimentally and then to find out how much is necessary to cure it.

An experiment of this nature was carried out in England under he auspices of the Medical Research Council between October, 944, and February, 1946. A basal diet containing less than one milligram ascorbic acid, but adequate in every other way, was given o a group of twenty volunteers. Ten of this group remained on the deficient diet, while the remaining members were given various upplements. Many clinical and physiological tests were made ncluding the effect of an ascorbic acid deficiency on the healing of wounds.

Scurvy developed in all the volunteers on the deficient diet, the irst signs being a change in the hair follicles which later became haemorrhagic and formed characteristic scorbutic spots. Scorbuti gum changes began to appear after 26 weeks of deprivation. Thes scorbutic symptoms were all cured with 10 mg. of ascorbic aci daily. Seven volunteers who received 10 mg. ascorbic acid from th start never developed scurvy.

It would seem, then, that since 10 mg. ascorbic acid can bot prevent and cure scurvy, this amount could be considered a minimum protective dose. A "protective dose" is probably not enoug for good health and so the British standard is three times this allowance, or 30 mg. daily. This was also the allowance recommende by the League of Nations in 1938. The Canadian standard for adult and children is the same—30 mg. daily. American "Recommende Allowances" vary somewhat according to age (Appendix 3).

Difference between American "Recommended Allowances" and Canadian Standards

Individuals vary in their requirements for all nutrients. Thes variations are partly due to differences in size and so, in Canad weight is used as a prominent factor in setting up Canadian dietar standards. Although in the States weight is not considered as a essential factor, yet the American Allowances for calories, protei mineral matter and fat-soluble vitamins are very similar to th Canadian.

That is not the case with the water-soluble vitamins—ascorbi acid and the vitamin B complex. In the States, as explained b Wilder, the Allowances are high enough "to include a margin o safety designed to permit additional benefits as well as to cove individual variations". The Canadian standards are based o averages and leave other considerations to the individual.

Food Assay for Ascorbic Acid

The following methods are commonly used in finding the ascorbi acid value of foods.

1. **Biological.** Since the rat can synthesize ascorbic acid, i

University of Manitoba, 1955

Cabbage (1 serving)
Grapefruit (¼ large)
Orange (½ large)

Tomato juice (¾ c.)
Orange juice (⅓ c.)
Green pepper (1 oz.)

Apple juice (vitaminized) (⅖ c.)
Potato (1 serving)
Turnip (1 serving)

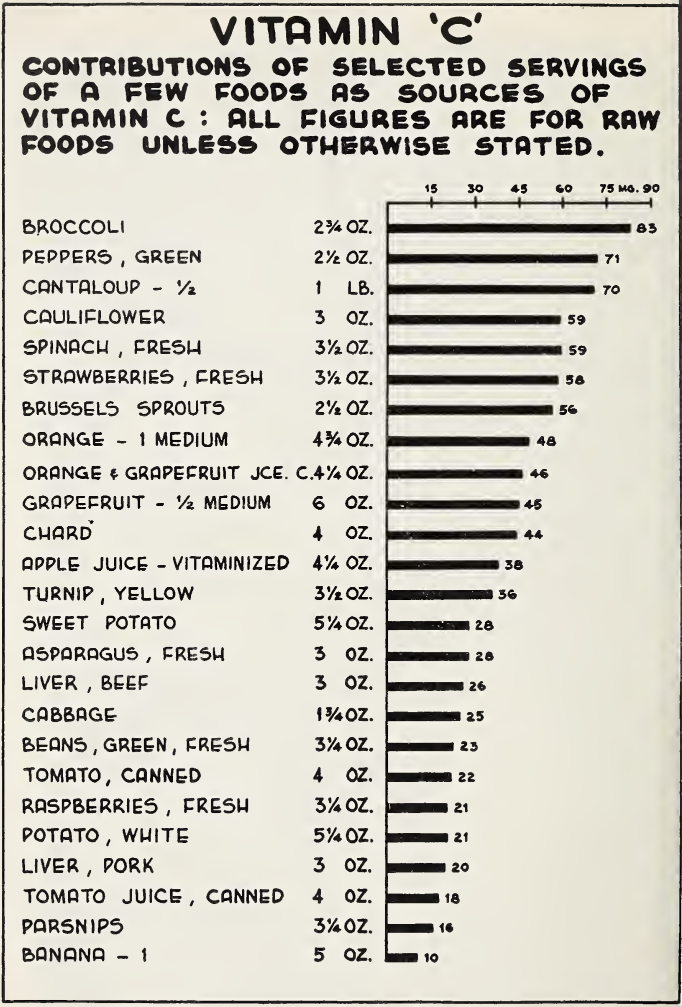


FIGURE 23. VITAMIN C

(Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare Ottawa)

annot be used for assay purposes for this vitamin. The guinea-pig, .owever, is unable to manufacture ascorbic acid, and is particularly ensitive to a lack of it in the diet. It has therefore been chosen as he most suitable animal for bioassay purposes. The test depends on ıe growth of the guinea-pig, the prevention of scurvy and the rowth of the odontoblasts of the incisor teeth. The odontoblasts re cells which line the pulp of the tooth and form dentine (see igure 33).

2. Chemical Method. Chemical methods are simpler and uicker than bioassays and are much less expensive. The basis of this hemical test is the ability of ascorbic acid to reduce the dye 2, -dichlorophenol-indophenol. The measurement of the amount of ye that was reduced by the food tested may be made by titration* r by means of a photoelectric colorimeter. Since other materials esides ascorbic acid are capable of reducing the dye, the test must e carefully controlled and all interfering substances accounted for efore an accurate estimate is made.

This method is in common use today.

Ascorbic Acid in Food

The best sources of ascorbic acid are fresh, raw fruits and egetables. Probably the best liked and most widely used is some orm of citrus fruit, either orange or grapefruit or their juices. lthough citrus fruits are very popular, they are by no means the nly sources. Strawberries are rich in vitamin C, so also are vegeables like cabbage, green pepper, turnips, tomatoes and potatoes. lthough apple juice normally contains practically no ascorbic acid, large part of the canned apple juice sold in Canada has had nthetic ascorbic acid added.

The foods shown in Figure 22 are all equal to one another in the mount of ascorbic acid they contain, that is 30 mg. Half of a large orange or about ⅓ c. of orange juice is taken as the base and we have a serving of cabbage, of turnip or of potato all equal to th ½ large orange in ascorbic acid value. It should be mentioned th this is true only if the vegetables are eaten raw—made into cabba salad or turnip wedges. When cooked, all vegetables lose som ascorbic acid value. The amount lost depends on the method preparation, cooking method used and the length of time the fo is cooked.

---

*A volumetric method of assay. It is done by adding a liquid in ıeasured volume to a known volume of another liquid until the "end oint" is reached. This is shown by a change in colour.

Tomato juice is a very good source of vitamin C too. It h approximately half the vitamin value found in the same amount orange juice. By constant breeding of those varieties of tomato high in vitamin C content, the future may bring us a tomato th is the equivalent of the same-sized orange in its ascorbic acid valu

Perhaps the most potent of all substances, as far as ascorbic ac content is concerned, is the rose hip or seed of the wild rose. The hips, when picked in the fall and made into a puree, contain 3 mg. per 100 grams, which is 9 times richer in vitamin C than oran juice. It is not as palatable, however, and would never be popular as foods which contain much less but which are well like

In Figure 23, the bar graph shows the comparative value servings of fruits and vegetables. The only one that has ascorb acid added is apple juice.

Losses in Ascorbic Acid Value

There are many ways in which food loses its ascorbic acid valu There is some deterioration in storage, depending upon temperatu control and time stored. There is a great deal lost in cookin depending upon the method of preparation as well as the method cooking. In the preservation of food also some vitamin value is los

Potatoes are used daily by Canadians and are a very good sour of ascorbic acid, particularly when new. There is some deterioratio due to storage as shown in Table 17.

ABLE 17. ASCORBIC ACID VALUES OF POTATOES—NEW AND STORED

	AMOUNT grams	ASCORBIC ACID mg.
otato, white or Irish		
New	100*	26
Dug and stored	100	24
Stored 2 months	100	14
Stored 5 months	100	10

aken from "Table of Food Values Recommended for Use in Canada".

*100 grams is considered a small serving. 150 grams (⅓ lb.) is verage.

Boiling potatoes with their jackets on, or baking them, will retain ost of their value since ascorbic acid is water soluble. For the ame reason all vegetables should be left in as large pieces as ossible, cooked in as little water as possible and as short a time s will give a palatable result. The amount dissolved out of the food nd found in the water will vary considerably due to the above actors.

Ascorbic acid is very stable in an acid medium but is destroyed y an alkali: soda added to any food increases the destruction of e vitamin.

Perhaps the greatest loss in the home is caused by oxidation. Food ft standing at room temperature will quickly deteriorate. Fresh uit and vegetables should be used quickly or else stored in the frigerator for only a short time.

When preserving vegetables by freezing they must be blanched in eam first so as to kill the enzymes normally present in the food nd which would cause it to spoil. This blanching of necessity estroys some ascorbic acid but not as much as if the enzymes had ot been destroyed.

In canning, such foods as tomatoes, tomato juice and citrus fruit uices all retain most of their ascorbic acid value because of their cidity. For best retention, however, the canning must be done in a acuum since ascorbic acid is destroyed by oxidation. This is the commercial method and retains more ascorbic acid than th ordinary home-canning method.

Losses in the ascorbic acid value of food, then, can be minimiz by careful handling, preparation and cooking.

EXERCISES

1. What would you suggest as a cheap source of ascorbic acid?
2. Calculate the ascorbic acid content of the food you ate yesterda Use Appendix 6.

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hapter 9.

VITAMIN B FAMILY

At the beginning of the twentieth century, what is now called the itamin B family with its many component parts was thought of as single vitamin. Today we have separated out and named eleven ifferent vitamins from the original vitamin and there are unoubtedly more still to be isolated and synthesized.

Here is a list of the vitamins with the most important ones entioned first.

1. Thiamine
2. Riboflavin
3. Niacin
4. Pyridoxine
5. B_{12} (cobalamine)
6. Folic acid (citrovorum factor*)
7. Pantothenic acid
8. Biotin
9. Choline
10. Inositol
11. Para-aminobenzoic acid

The first three, thiamine, riboflavin and niacin, are the most mportant of all, and will be discussed in some detail.

Thiamine (B_1 or Aneurin)

The disease beri-beri (polyneuritis) has been known for centuries. is still common in the Far East among the people existing mainly n polished (white) rice. It affects the nerves, causing a paralysis the legs which shows itself in a peculiar gait. In some cases the eart is enlarged and the heart-beat is slowed (bradycardia). A lack appetite with a corresponding loss in weight is also present.

Although this disease was known for many years, it was not until 890 that the cause was known. It was at this time that a Dutch ientist, Eijkman, while working in Java, noticed a peculiar disease in hens. These hens were fed the scraps from the table those suffering from beri-beri and, to his surprise, developed t same symptoms as the patients. He cured the hens by feeding the whole rice (including the bran) instead of white rice, which h the bran removed.

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*The active form of folic acid.

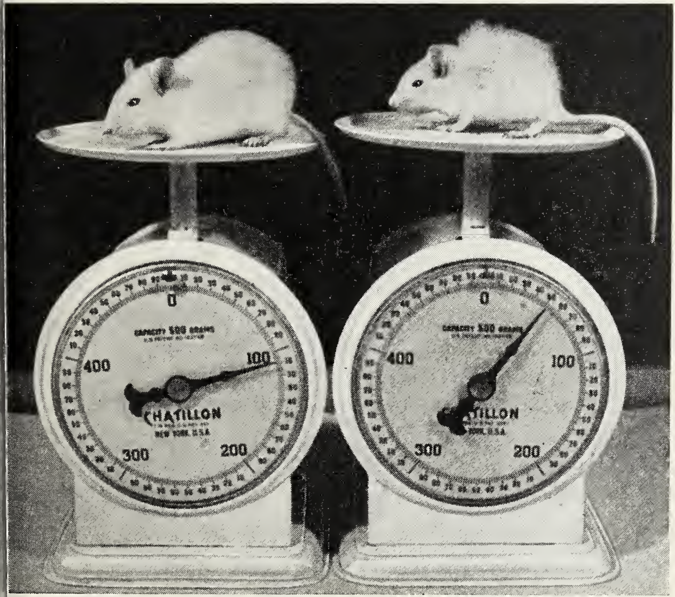
This was the beginning, but it was not until 1927 that the acti substance, thiamine, was isolated from rice bran. Later it w synthesized.

In the Philippines, the large number of deaths from beri-be constitute a major health problem. In the early part of this centu an attempt was made to meet this problem by urging the use tiki-tiki, an extract of rice polishings. The use of this extract in t city of Manila materially reduced the deaths from beri-beri. T rest of the country, however, used little tiki-tiki. By 1952, enrich rice was introduced commercially in two provinces of the Phili pines. At the request of FAO-WHO, a team of experts evaluat this programme, and the result was published in 1954 in a bullet called "Rice Enrichment in the Philippines". Undoubtedly t enrichment programme was helpful, but it did not solve all the problems. The materials for the "premix" used in the enrichme had to be imported and special machinery installed, which increas the cost of rice by 2%. Then too, the Philippines import rice whi in turn created another problem, since it was not enriche Undoubtedly modifications and adjustments will be made to sol these problems.

In Canada, the disease beri-beri is practically unknown. The are some cases, however, where poor food habits lead to mi symptoms. The chronic alcoholic may lack the appetite to eat foo containing thiamine, and some patients with digestive disturbanc leading to poor absorption may not be receiving enough throu their food. There may be others who are faddy in their habits a do not choose the right food. They may suffer some mild sympto of a lack of thiamine such as irritability, a loss of appetite, and a la of muscular tone in the digestive tract which in turn may cau constipation.

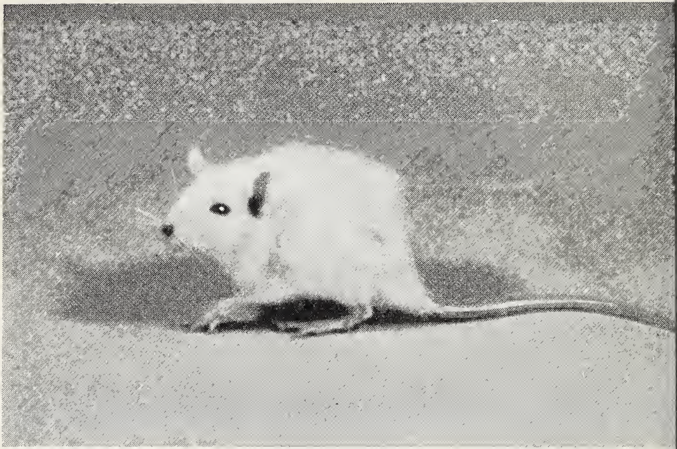
Experimental Data on Thiamine

It is now possible to prepare purified diets and omit one nutrient n order to see the effect on an experimental animal. In Figure 24 re two rats standing on scales to show the difference in weight. At he beginning of the experiment both rats (litter mates) weighed he same, 60 grams, and were quite healthy. They were given the iets listed in Appendix 4, one without thiamine, the other with hiamine. In four weeks' time the rat without thiamine showed very symptom of polyneuritis, including slight paralysis of the gs, loss of appetite and loss of weight. Figure 25 is another picture f the thiamine-deficient rat. The weight curves of the rats are own in Figure 26.



University of Manitoba, 1955

IGURE 24. EFFECT OF THIAMINE AND LACK OF THIAMINE (RATS)



University of Manitoba, 19

FIGURE 25. RAT WITH POLYNEURITIS

Properties and Action of Thiamine

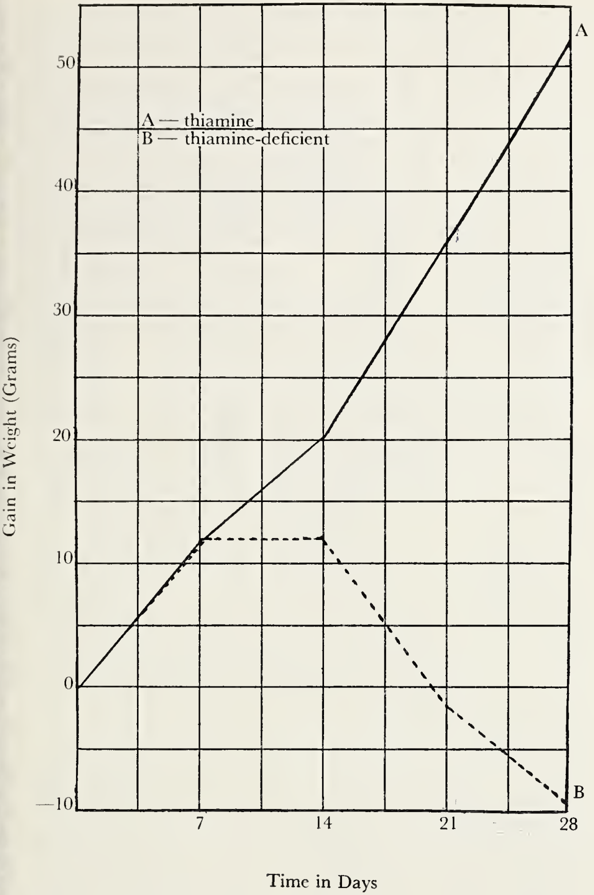
Thiamine is soluble in water and so is lost in the cooking-wate If vegetables are soaked before cooking, there will be some loss to In the dry form, thiamine is stable, but is destroyed by moist heat the amount lost depending upon the length of the cooking processe Alkali destroys it too, so soda should not be used in cooking. Aci helps to preserve it.

Thiamine has a special function in relation to carbohydrate. I acts as a co-enzyme and aids in the oxidation of pyruvic acid whic is formed as a result of carbohydrate metabolism. If there is n enough thiamine, pyruvic acid accumulates in the blood instead being further oxidized. The amount of thiamine needed is directl proportional to the carbohydrate consumed.

Methods of Assay

The amount of thiamine in food is determined by several differen methods.

1. Biological. The animal commonly used in this method is th



IGURE 26. EFFECT OF THIAMINE AND LACK OF THIAMINE IN THE DIET OF RATS

University of Manitoba, 1955

rat. The amount of thiamine in the food may be estimated by th growth of the rat or its cure after convulsions have been produce The bradycardia test is also used, particularly by Harris in Englan In this test, the rate of the heart-beat falls in the deficient rat an goes back to normal when cured. The duration of the cure is th measure of the potency of the substance.

2. Chemical or Thiochrome Method. Thiamine is oxidized t thiochrome.* The thiochrome thus formed is measured by it fluorescence and this amount can then be stated in terms thiamine.

3. Microbiological or Yeast Fermentation Method. Thiamin stimulates the growth of yeast. This growth rate is measured an calculated in terms of the thiamine present.

Thiamine in Food

When there are deficiencies in other vitamins, there is a singl food source which is so rich in the vitamin that one serving can fulf all requirements. For instance, a normal serving of orange juic will protect from scurvy, a teaspoon of cod-liver oil will preven rickets, and one large serving of a green- or yellow-coloured vegetable daily will satisfy the need for vitamin A. This is not the cas with thiamine. Although there is some thiamine in many food there is no single source that can be depended upon to provide dail all the thiamine needed for health. So thiamine must be obtaine from many different foods.

There are some foods, however, that are normally eaten ever day and so provide a large part of the daily requirement eve although the individual amounts are small. Bread—whole-wheat o enriched—is a good source and so is rolled oats. Potatoes too ar used daily and help to supply the needed thiamine. Other vegetabl will also provide a little. Green peas are a very good source and s are dried peas and beans. Milk contains some thiamine, one pin supplying as much as 4 slices of whole-wheat bread. Wild ric contains the same amount of thiamine as converted rice. It is onl ⅔ as rich in thiamine as brown rice (cultivated).

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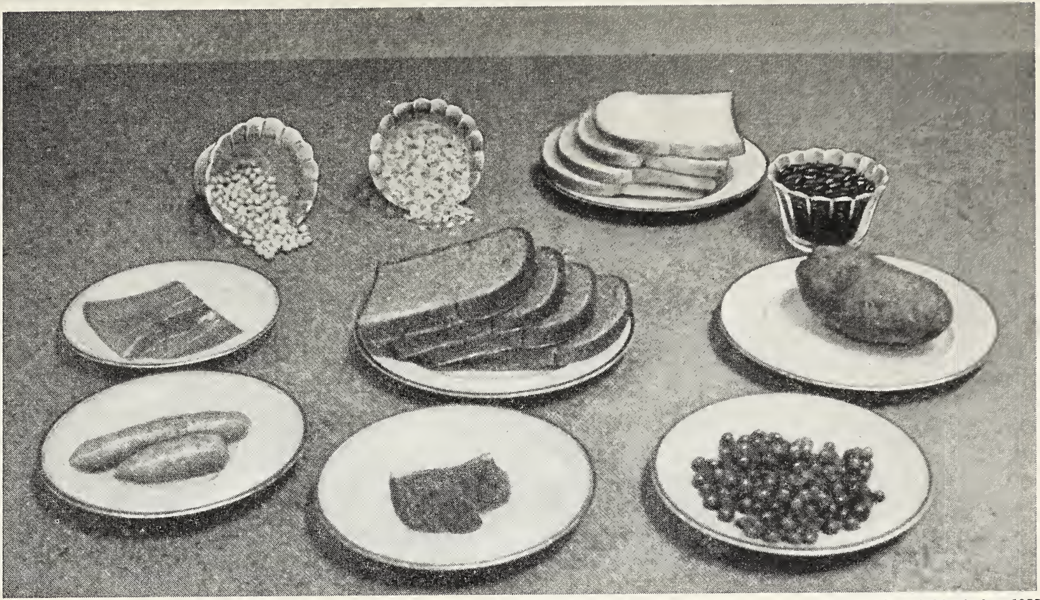
*A quantitative colorimetric method for the assay of thiamine.

FIGURE 27. 4 SLICES OF WHOLE-WHEAT BREAD EQUIVALENTS IN THIAMINE (0.2 mg.)



University of Manitoba, 1955

Navy beans (⅔ serving)
Ham (½ slice)
Sausage (1½)
Rolled oats (1 serving)
Whole-wheat bread (4 slices)
Pork chop (½ chop)
White bread, enriched (4 slices)
Wild rice (⅔ c.)
Potato (½ lb.)
Green peas, frozen (1 serving)

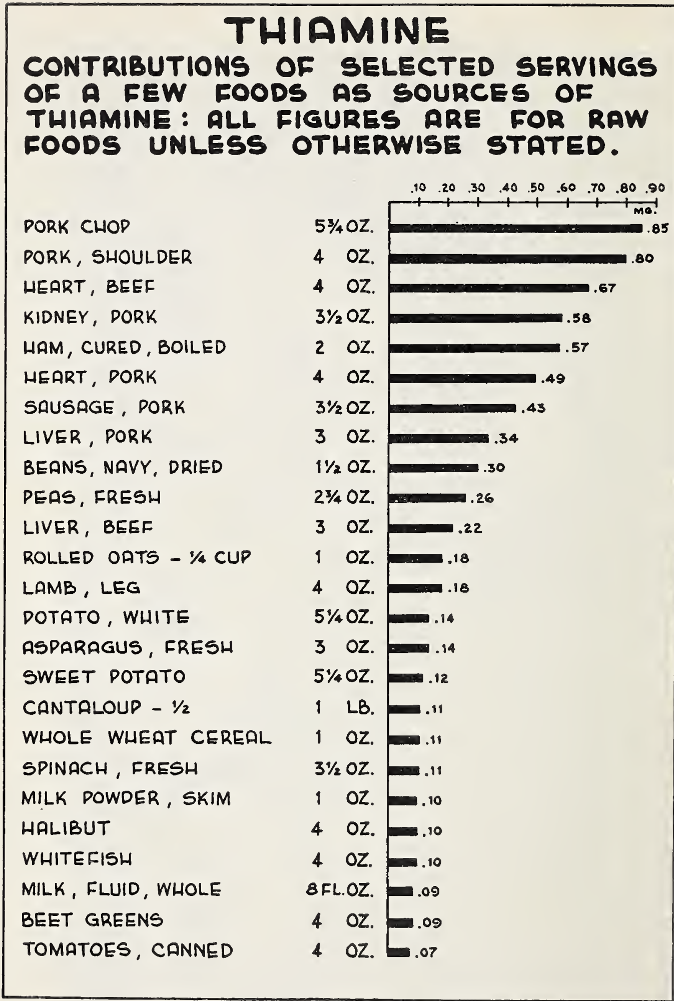


FIGURE 28. THIAMINE

(Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare Ottawa)

In Figure 27 the amount of thiamine in 4 slices of whole-wheat bread (0.2 mg.) is taken as the base and all the other foods are equivalent to it in thiamine content. Pork products are the best sources of thiamine. It takes only ½ slice of ham or 1½ sausages to be the equivalent of 4 slices of whole-wheat bread. A large pork chop contains enough thiamine to be the equal of one pound of whole-wheat bread as far as thiamine is concerned. There is of course some loss in cooking.

Losses in Cooking

Since thiamine is water-soluble like ascorbic acid, there is some oss in the cooking-water and the smaller the pieces into which the ood is cut for cooking, the greater the amount that is dissolved out nto the cooking-water. If this water is used to make soup or gravy, t is not all lost. Some thiamine is destroyed by heat—the higher he temperature and the longer the time held at the high temperaure, the greater the loss of thiamine. Then, too, thiamine is destroyed by an alkali, so soda added to any food containing thiamine increases the destruction. Dry heat is less destructive than moist heat so baking retains more vitamin than boiling.

Bread—Whole-Wheat and White

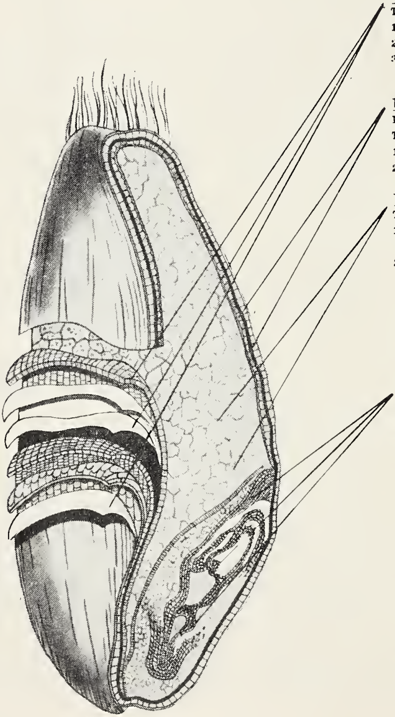
All over the world cereals are recognized as the "staff of life". n some countries cereals form 80% - 90% of the diet of the people; in Canada the percentage of total calories consumed in the orm of cereals is approximately 30%. This is mainly in the form f wheat, although other cereals, particularly oats, are used as well.

The wheat berry contains a fair amount of thiamine, as well as ther parts of the B complex, but they are found mostly in the bran ayers and the germ, both of which are removed in the milling rocess when white flour is made. The endosperm which is left ontains protein and calories, but very little if any of the B-complex itamins.

Only about 72% of the wheat berry is used in making white flour, the other 28% is used as feed for animals. This low extra tion was deemed a waste in the United Kingdom during the wa and a high-extraction flour using 85% of the wheat berry was ma compulsory. This high-extraction flour was made into the Nation

WHOLE WHEAT

This cross section of a grain of wheat shows the various nutrients in the different parts of the grain.



The Bran - the brown outer layers. This part contains:---
1. Bulk-forming carbohydrates
2. B vitamins
3. Minerals, especially iron

The Aleuron Layers - the layer located right under the bran. They are rich in:-----
1. Protein
2. Phosphorus, a mineral

The Endosperm - the white center. This is mainly:---
1. Carbohydrates (starches and sugars)
2. Protein

This is the part used in highl refined white flours. Less re fined flours and refined cereal are made from this part and vary ing amounts of the aleuron layer

The Germ - the heart of whea (embryo). It is this part tha sprouts and makes a new plant whe put into the ground. It con tains:---
1. Thiamine (Vitamin B_1). Whea germ is one of the best fo sources of Thiamine.
2. Protein - this protein is value comparable to the pr teins of meat, milk and chees
3. Other B vitamins
4. Fat and the fat-soluble Vit min E.
5. Minerals, especially iron.
6. Carbohydrates

Courtesy of the Ralston Purina Compa

FIGURE 29. WHOLE WHEAT

Wheatmeal Loaf. This bread was undoubtedly superior, nutritionally speaking, but it was not as popular as it deserved to be. Today (1955), rationing is over and white bread is back on the market again in the United Kingdom. This bread is made from flour that has had specified amounts of iron, thiamine, niacin, and calcium carbonate added to it.

In Canada, an attempt was made to popularize a bread made from 78% of the wheat. It was called "Canada Approved" and contained about one-half of the thiamine normally present in the wheat along with other parts of the B complex. It was creamy in colour and had a pleasant flavour. It was similar in protein and calorie value to ordinary white bread. Apparently it was more difficult to make acceptable bread from "Canada Approved" flour and there was insufficient customer support to make this bread popular.

Since February, 1953, Canadian law allows the "enrichment" of flour. It also states what is meant by "whole-wheat bread" and requires labelling of same. It reads as follows:

"*B.13.022.* Enriched Bread, Enriched White Bread shall be bread baked from a dough in which enriched flour is the only flour used, and shall contain not less than two per cent by weight of the flour used as skim milk solids and shall contain in each pound not less than 1.1 milligrams and not more than 2.4 milligrams of thiamine, not less than 0.8 milligram, and not more than 1.8 milligrams of riboflavin, not less than 10.0 milligrams and not more than 15 milligrams of niacin or niacinamide and not less than 8.0 milligrams and not more than 12.5 milligrams of iron.

B.13.023. Vitamin B White Bread (Canada Approved) shall be bread baked from a dough in which Vitamin B White Flour (Canada Approved) is the only flour used and shall contain not less than:

(a) four per cent, of the weight of the flour, of skim milk solids,
(b) in one pound of the bread 0.54 milligram of thiamine together with the attendant members of the vitamin B complex.

B.13.024. Vitamin B White Bread (Canada Approved) in the making of which enriched vitamin B white flour is the only flou used, shall be designated ‘Enriched Vitamin B White Bread’.

B.13.025. Raisin Bread shall be bread that contains in each poun of bread not less than 50% by weight of flour used of raisins or mixture of raisins & currants. If mixture is used at least 35% b weight of flour used must be raisins.

B.13.026. (naming the percentage) Whole-Wheat Bread shall b bread with or without the addition of caramel, in which the name percentage of the flour used shall be whole-wheat flour. (To b called Whole-Wheat Bread the named percentage must be at lea 60 per cent of the total weight of flour used.)

B.13.038. Brown Bread shall be bread coloured by the use of whol wheat flour, graham flour, bran, molasses, or caramel or a combination of them. (If no whole-wheat flour was used in Brown Brea the label must say so; if some whole-wheat flour was used the lab must state the percentage. If caramel or molasses were used t darken the bread the label must state ‘Coloured with . . .’).”

Since in milling almost all of the valuable vitamins and mineral that are originally found in the wheat grain are removed, and b enrichment only some are put back, it is understandable that th process is viewed with suspicion by those interested in better nutrition. To make matters worse some lysine, one of the essentia amino acids, has been removed in the milling process.

However, there are some points that need to be taken int account on the other side of the picture. Whole-wheat flour canno be stored like white flour, and at the present time, there is littl consumer acceptance of the whole-wheat bread even at the level o 60%. Then, too, there are some people who because of digestiv disturbances cannot eat roughage of any kind.

In Canada, we have unlimited choice of food, and if we do no get all the vitamins and minerals we need in our bread, we probabl get them in abundance in other foods. It is only those living on restricted diet who may suffer.

Perhaps, in the future, our scientists will solve the problem o storage and our millers and bakers the problem of consumer acceptance.

In the United States, bread has been enriched since 1941. Since then, other cereals have also had additions and at the present time, macaroni, corn and rice have also been enriched.

Thiamine Requirement

There have been various methods used in estimating thiamine requirements, but at the present time there is no unanimity in the results of research workers. This is due to the fact that there is no agreement on when the body is adequately supplied. There is agreement, however, that the amount of thiamine required is probably proportional to the calorie intake. There is also suggestive evidence that thiamine, riboflavin and niacin can advantageously be supplied in about the proportions of 3:5:30.

The requirements for all of the B-complex vitamins is further complicated by the fact that some synthesis of these factors takes place in the intestinal tract. The amount is not constant and will vary according to conditions in the digestive system. Treatment with sulpha drugs to combat disease will cause the destruction of bacteria responsible for the production of vitamins. This causes another variable in the amount required.

The tentative standard for thiamine, riboflavin and niacin used in Canada is as follows:

Thiamine : 0.3 milligrams per 1000 calories
Riboflavin : 0.5 milligrams per 1000 calories
Niacin : 3.0 milligrams per 1000 calories

In the absence of other evidence, juvenile requirements are the same.

The recommended daily dietary allowances used in the United States are given in Appendix 3.

EXERCISE

List the food you ate yesterday, stating amounts. Calculate calorie value and thiamine value, using Appendix 6.

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Chapter 10.

RIBOFLAVIN, NIACIN AND OTHER VITAMINS OF THE B FAMILY

1. Riboflavin

Properties. Riboflavin is a very stable part of the B complex. It orms fine yellow crystals, when in a pure state, and is bitter-tasting. n solutions it shows a characteristic yellow-green fluorescence. It s stable to acid and destroyed by alkali just as thiamine is. It is, f course, water-soluble and when in a liquid form it is destroyed by ght. Milk is an excellent source of riboflavin, so it should not be eft in the sunlight for any length of time if the vitamin content is o be conserved.

Action of Riboflavin. Other vitamins that have been mentioned o far have cured a disease. For instance: vitamin D cures rickets, hiamine cures beri-beri, and ascorbic acid cures scurvy. Riboflavin oes not cure a disease, but it helps in the cure of other diseases uch as pellagra. It has a beneficial effect on certain sore spots that ppear round the mouth and nose when it is lacking in the diet. It also necessary for growth.

Methods of Assay. There are three methods of assay: biological, hemical, and microbiological. The biological is based on the rowth of the rat under standard conditions. The chemical is based n the colorimetric determination of the colour of riboflavin or of umiflavin into which it may be changed. The microbiological method depends on the fact that riboflavin stimulates the growth of pecial bacteria which produce lactic acid. This lactic acid can e measured so that the amount of riboflavin present can be etermined.

Riboflavin Content of Food. The variety meats are excellent ources of riboflavin. Milk and cheese also are very good sources.

As will be noted in Figure 30 below, milk is the base of the riboflavi equivalents. Each food contains the same amount of riboflavin a ½ c. milk (0.2 milligrams). Since 1 pt. of milk is the minimu allowance for children, they would automatically receive at lea 1 milligram from milk alone. This is almost enough to cover thei daily needs until adolescence.

Effect of Processing on Riboflavin. Riboflavin is not destroye by heat, but it is dissolved out in the cooking-water and is lost if th water is thrown away. Little, if any, is lost in baking or broiling. I is destroyed by light.

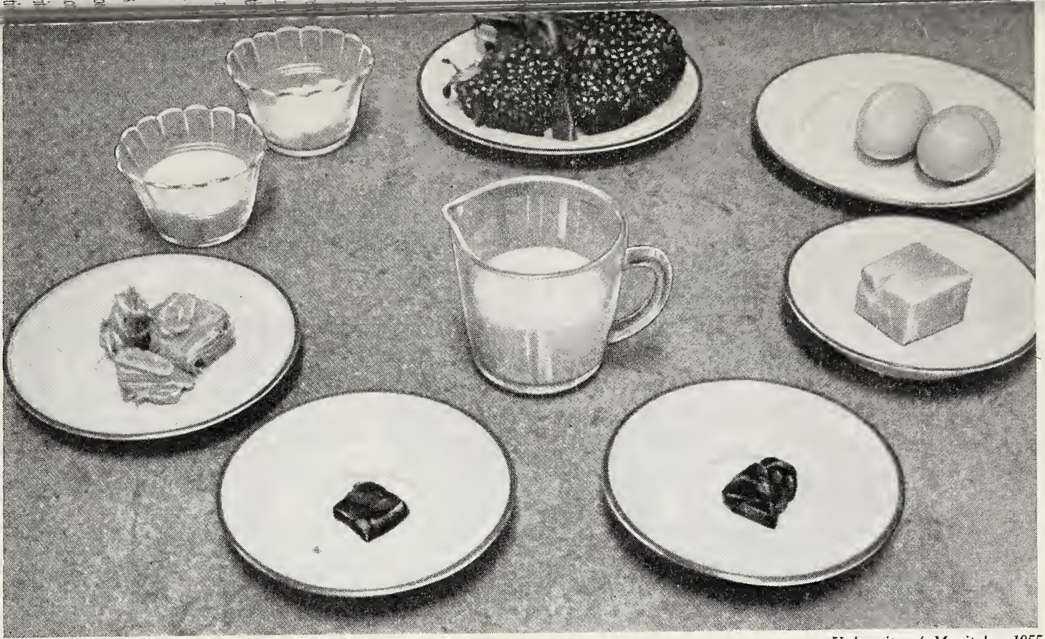
Requirements. It is difficult to state an exact requirement sinc it has not been settled when the body is adequately supplie Excretion tests are used as well as blood tests in an attempt to deriv basic data. Undoubtedly these tests will be standardized in th future.

For the present, the Canadian standard is based on the proportio of riboflavin to thiamine as stated on p. 97, that is, 0.5 milligram riboflavin per 1000 calories for both adults and children.

2. Niacin (Nicotinamide)

In niacin we have another vitamin which is a specific remedy fo a disease. It will cure the disease pellagra, which was prevalent i many countries of the world in the early part of this century. I was found in Italy, Egypt and the southern United States, as wel as many other places. It was always associated with poor diets, an at first it was thought to be a deficiency of protein. Since one of th essential amino acids, tryptophan, is the precursor of niacin, it is n wonder that there was some confusion over the role of protein. I was originally called the pellagra-preventing (P-P) factor.

Symptoms of Pellagra. There are three main symptoms o pellagra often called the 3 D's: (1) Dermatitis; (2) Diarrhoea (3) Dementia. There is an inflammation of the skin which occur on both sides of the body at the same time. It is red and very irritating, as it both burns and itches. Sunlight aggravates the condition The mucous lining of the mouth, stomach and intestines become



University of Manitoba, 1955

Milk, evaporated (¼ c.) Milk, dried (2 tbsp.) Broccoli (2 servings) Eggs (1½)

Salmon (1½ servings) Milk, fluid (½ c.) Cheese, cheddar (2 oz.)

Liver, beef (⅕ oz.) Kidney (¼ oz.)

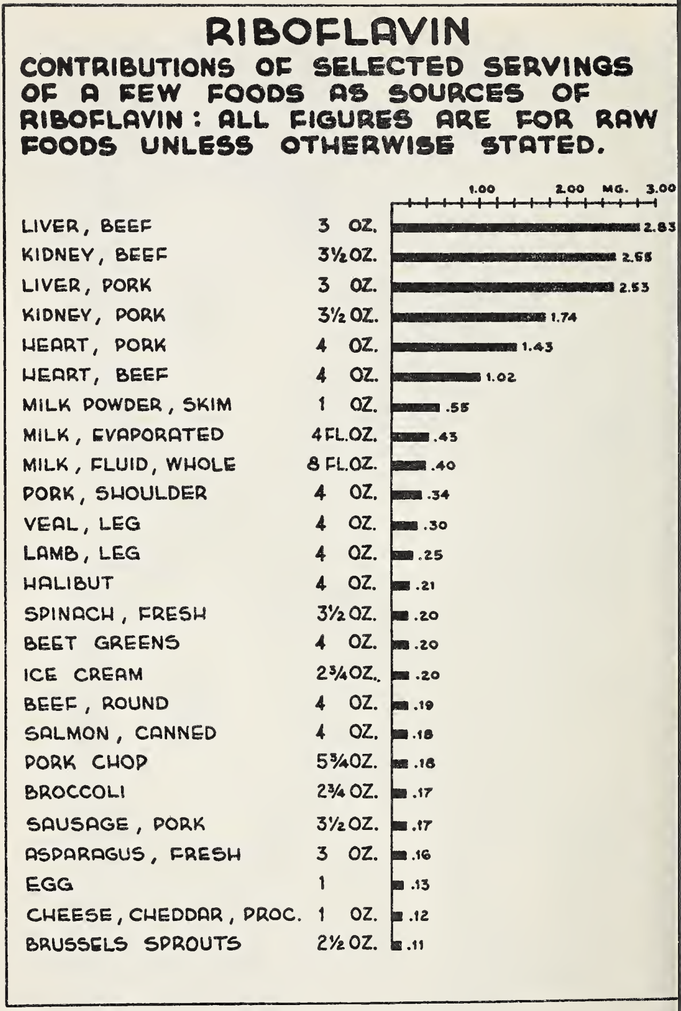


FIGURE 31. RIBOFLAVIN

(Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare Ottawa)

sore and inflamed. There is loss of appetite and diarrhoea develops. Later nervous symptoms show with gradual deterioration ending in mental confusion and death.

Pellagra is often called a multiple-deficiency disease. Although niacin is considered a cure and does cure the patient up to a point, a complete cure is only achieved by using thiamine and riboflavin as well as niacin. It is difficult to separate out the symptoms which are cured by any one of the three, but best results are obtained when the patient receives the B complex rather than just niacin.

Methods of Assay. There are three methods of assay: biological, chemical, and microbiological. Since the rat can make all the niacin it needs, it is not suitable for assay purposes. The dog is used and the prevention or cure of "black-tongue" in dogs is the standard used. Chemical methods are used too, but the commonest method s the microbiological. Niacin is a growth factor and as such timulates the growth of special bacteria under standardized conditions. These bacteria produce lactic acid which can be measured. From this the amount of niacin can be determined.

Niacin in Food. The best sources of niacin are meat and fish with liver particularly high. Both heart and kidney are also very good sources. Variety meats on the whole are surprisingly good ources of all the B-complex vitamins. Milk is not a good source of niacin, but since it contains tryptophan, the precursor of niacin, it s better than is at first apparent. Cereals are comparatively poor, orn containing less than wheat.

There is little loss in cooking as niacin, like riboflavin, is very table to heat. There will be some dissolved out in the cooking-water like all water-soluble vitamins.

Requirements. Like all the B-complex vitamins, it is difficult to et a standard partly because niacin is synthesized in the intestinal ract, and partly because it has not been settled when the body is dequately supplied. Excretion tests and blood tests will undoubtedly be standardized in the future. For the present, the Canadian tandard is based on the proportion of niacin to thiamine as stated on p. 97, that is, 3.0 milligrams per 1000 calories for both adults nd children.

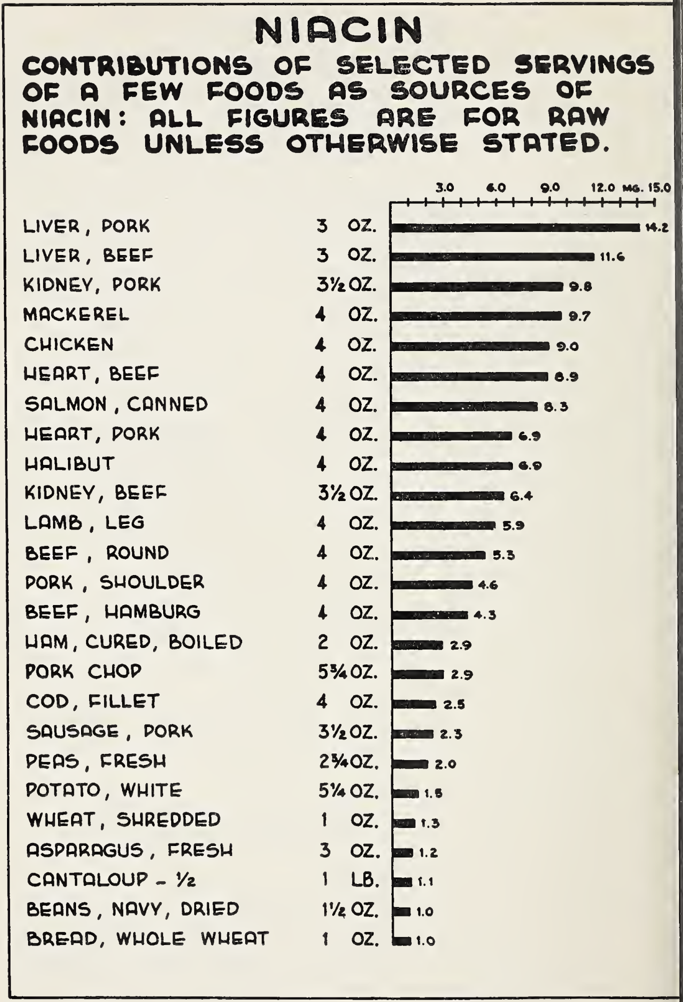


FIGURE 32. NIACIN

(Healthful Eating, 1952. Nutrition Division, Department of National Health and Welfare Ottawa)

3. Other Vitamins of the B Complex

Thiamine, riboflavin and niacin are the most important members f the B complex. There are, however, eight other parts that have een isolated and synthesized. Of these, there are three, pyridoxine, olic acid, and B_{12}, that are considered necessary to normal nutri- ion in man. Under ordinary circumstances and with good health, deficiency does not appear, since they are widely distributed in rdinary foods. Like thiamine, riboflavin and niacin, they are ynthesized by bacteria in the digestive tract.

Pyridoxine (B_6). In experimental animals, pyridoxine deficiency esults in anaemia, skin lesions and convulsions. Treatment with yridoxine of patients suffering from anaemia or epileptic seizures as led to disappointing results. Apparently this vitamin is so idely distributed in food that a natural deficiency is most unlikely occur.

Pyridoxine is necessary for growth and is considered a help in e metabolism of both fats and proteins.

Folic Acid (citrovorum factor). Folic acid has been called by ifferent names in research literature, e.g., vitamin M (needed by onkeys) and B_c (preventive of macrocytic anaemia in chicks) as ell as others. It is now known to be the precursor of the citro- rum factor which is the active substance. Both folic acid and the trovorum factor may be found in a free or bound form. If in a und form, it is freed by the action of enzymes. Ascorbic acid will tivate the enzymes that set it free.

Folic acid is of great value in the treatment of macrocytic aemias. In these anaemias, the red blood cells are fewer in mber and larger in size than are normal red cells. Folic acid mulates the production of red blood cells of normal size. It is *not* eful in treating pernicious anaemia, which needs B_{12} instead.

Vitamin B_{12} (cobalamine). Although liver or an extract made om liver had been used for twenty years in the treatment of rnicious anaemia, the search for the active substance was un- ailing until 1948 when vitamin B_{12} was isolated from liver. It as found to be very potent in its effect on the pernicious-anaemia tient. Instead of eating large quantities of liver or taking an injection of liver extract every week, it is now possible to keep tl patient in good health by injections of B_{12} at approximately s months' intervals.

Besides being very useful in the treatment of pernicious-anaem patients, B_{12} is similar to, if not actually the same as, an "anim protein factor" (APF) which stimulates growth. It is now used commercial food mixes for poultry and cattle with good results.

B_{12} is red in colour and contains the mineral cobalt. It is stal in neutral solutions, but loses some of its potency in acid or alkali solutions.

Synthetic Vitamins. As can be seen from the previous discussi on vitamins, the essential ones have been isolated from foods a their chemical composition established. When the chemical formu of a vitamin was known, the next step was to synthesize it. Wh a vitamin is synthesized, the cost is reduced and it is possible n to buy vitamins rather cheaply in comparison with earlier cos This production of synthetic vitamins is of value to the doctor in treatment of illness.

Normal healthy people do not need to buy synthetic vitamins. the vitamins needed for health can be obtained from food. Canada's Food Rules are followed liberal amounts of all nutrie will be supplied. It is very poor policy to spend money on somethi not needed. It might actually be detrimental to have too large allowance of some vitamins which might cause an upset in th interrelationships with other vitamins. The only exception to t rule is the necessity for buying some form of vitamin D—synthe or otherwise—for all growing children and for mothers duri pregnancy and lactation.

EXERCISE

Analyse the food you ate yesterday for its calorie, riboflavin and nia content. Use Appendix 6.

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Chapter 11.

A HEALTHY DIGESTIVE TRACT

The digestive tract is composed of a series of organs connected by various tubes and making in all a length of about 30 ft. It is hrough this long tube that the food we eat passes and the waste is eparated out to be excreted. Sometimes the material in the tube is hurried along too quickly and then more material is excreted than hould be, and sometimes the material is not passed along quickly nough and constipation is the result. This clogging up of the digestive tract causes headaches and will result in pimples, dark ircles under the eyes and a tired, listless feeling. Fortunately, with areful selection of food and good hygienic habits, this condition can be corrected with a corresponding improvement in both appearance nd disposition.

Digestion

The process of digestion is to make food ready for absorption, ince the body is not nourished until the nutrients reach the blood. After food is eaten, it is changed in two ways: (1) mechanical, (2) hemical. Mechanically it is broken down into tiny particles by the ontinual movement of the muscles of the digestive tract. These muscular contractions (peristalsis) shove the material ahead at a teady pace so that it takes about 30 hours to complete the passage hrough the tract. Some people have a slow-emptying stomach, in which case the time is somewhat greater and others have a rapid-mptying stomach in which case the time will be less than 30 hours.

Chemically, food is broken down by the action of enzymes which re found in the digestive juices. These juices are poured into the ract from the mouth (saliva), the stomach (gastric juice), the ancreas (pancreatic juice), and the intestinal wall itself.

The nutrients, protein, fat and carbohydrate, are very large mol cules, and cannot be absorbed as such. The chemical action involv splitting these large molecules until the particles are small enoug to be absorbed. Proteins are digested to amino acids, fats to fatt acids and glycerol, and carbohydrates to simple sugars (glucose In these forms they are absorbed and carried by the blood to th tissues of the body.

Some foods, as eaten, contain material which cannot be digeste such as the cellulose in fruits and vegetables, and the coarse bra found in some cereals. These waste substances are excreted fro the body. The part of the food that is digested and absorbed spoken of as "digestible". The digestibility of foods varies fro about 90% in fruits to almost 100% in milk.

Elimination of Waste

When the normal wastes of the body are not properly eliminate the individual has a headache, lacks appetite and feels tired an sluggish. There are two reasons for this condition. The commo reason is a lack of proper muscular contractions, called aton constipation. The other is caused by a tightening of the muscul bands, called spastic constipation, and can only be cured by som method of relaxing the tight muscles. This type of constipatio should be treated by a doctor.

Atonic Constipation

To correct atonic constipation, two procedures are necessar (A) right choice of food and (B) good hygienic practices.

A. The Right Choice of Food

The right choice of food can be discussed under 4 headings:

1. Choose food that contains a residue. The digestive tra contains strong muscles which contract and expand in muscul waves sending the food forward. These muscular waves work be when there is bulk or residue present. This is furnished by fruits and vegetables, by whole-grain products and by legumes and nuts. Not only do they provide stimulation for the onward movement, but they soak up water, like a sponge, and make a softer stool. The amount of bulk necessary for normal peristalsis is found in the foods recommended by Canada's Food Rules, p. 2. Take all the fruit and vegetable recommended and use only whole-grain cereal and whole-wheat bread instead of refined cereals.

2. **Choose foods that contain organic acids.** Fruit of all kinds, either dried or fresh, is of great benefit. Apples, oranges, grapefruit and lemons all contain organic acids which are a stimulation to the movements of the digestive tract. Fruit or fruit juice on rising may be sufficient to start normal habits of elimination. Buttermilk is acid, too, and acts in the same way as the fruit does.

3. **Gas-forming Foods.** Gas-forming foods are not well tolerated by everybody but if only a little is taken it is beneficial. Too much s likely to cause discomfort. Gas-forming foods are cabbage, cauliflower, broccoli, onions, baked beans and molasses.

4. **Change the bacteria in the tract.** Normally the digestive ract contains many different kinds of bacteria. There are fermentaive bacteria, which are useful, and putrefactive bacteria which are not so desirable, as well as many others. A change in the number of putrefactive bacteria can be induced by decreasing the protein in he diet, on which the putrefactive bacteria act, and increasing the ermentative bacteria. This is accomplished by using acid milks, .g., buttermilk.

B. Good Hygienic Practices

The proper choice of food is necessary to correct constipation but ood hygienic practices are important too. They can be discussed nder three headings:

1. **Normal Muscle Tone.** Healthy muscle tone is a great asset. Anyone who is accustomed to taking part in gymnastic exercises r sport of any kind probably possesses normal muscle tone. Those

individuals who walk to and from school or work, are also likely t have good muscle tone. There are many, however, who do not wal to work and who do not participate actively in any sport. Thes are the ones who should develop the abdominal and intestin muscles particularly. Perhaps twenty minutes' exercise a day woul be sufficient.

2. Regularity in Elimination. Establishing a routine for dail elimination is very useful. If at all possible, elimination should follo breakfast. A good breakfast, which includes fruit or fruit juice o rising, and enough time to eat the cooked cereal with milk, will star muscular contractions and help in getting the routine started. It i easier to establish a routine of this nature with children and onc established, it will be of great benefit. In many cases, nervousness o nervous tension will upset this routine, but when the strain is ove proper elimination will return. Perhaps insufficient sleep fo relaxation is the real difficulty.

3. Use of Laxatives. The use of laxatives is not recommende unless ordered by the doctor. They may be needed occasionally, bu they do not cure the disorder, whatever it is. The slower method choosing the right food and following good hygienic practices is th only safe way.

EXERCISE

Write a leaflet on the correction of constipation suitable for a Grade student.

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Chapter 12.

NUTRITION AND DENTAL HEALTH

Nature has provided us with two sets of teeth; the first set, twenty in all, is temporary and is replaced by the second or permanent set which should last through life. The first permanent tooth appears about the age of 6 years and by the time the child is 12, the emporary teeth have all disappeared and permanent ones have appeared in their place. By the age of 18 all permanent teeth, hirty-two in number, should have erupted.

DIAGRAM OF A TOOTH
(Canada's Health and Welfare)

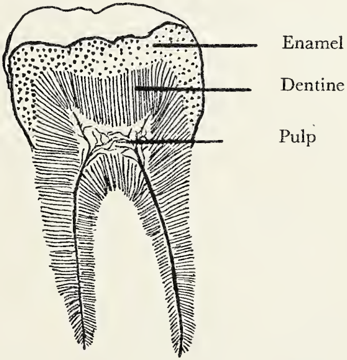


FIGURE 33. DIAGRAM OF A TOOTH

Looking at Figure 33 above, it will be seen that dentine makes up he large part of the tooth. It is covered by enamel, which is the ardest substance found in the body. Inside the dentine is the soft ulp of the tooth which contains blood vessels and nerves. Nourishment reaches the tooth by means of these blood vessels. Lining th pulp chamber is a layer of cells called the odontoblasts which form dentine.

Dental Caries

Although the structure of the tooth seems so indestructible, it i unfortunately true that caries or decay is widespread. It is s common and is increasing to such an extent that it has become public health problem.

The following statement was taken from Canada's Health an Welfare bulletin for November, 1949:

> "Half of our three-year-old children have had one or more teet attacked by decay. Sixty percent of four-year-olds are in the sam position, 70% of five-year-olds and more than 90% of 12-year-olds By the time the age of 16 is reached, the average Canadian boy o girl has lost two permanent teeth. In a typical Canadian city, survey of a Grade 8 group of children disclosed that each child ha had an average of 7.5 permanent teeth attacked by decay. Only 1% of this group had no history of dental caries."

This is a startling statement. The obvious questions are: Wha has caused such a condition and how can it be averted in the future

Nutritional Factors Related to Healthy Teeth

There are many factors that are undoubtedly a help in combating dental caries, although the whole answer is still not known. Th most important factors are: (1) mineral matter (calcium, phosphorus and fluorine), (2) vitamins (vitamin D, vitamin A an ascorbic acid), and (3) sugar and acid.

1. Mineral Matter. Since the largest part of the tooth, th dentine, is composed of calcium phosphate, it means that these tw minerals must be present in the food eaten, then absorbed from th digestive tract, and finally carried by the blood to the teeth fo proper tooth development. If there is insufficient calcium an phosphate, or if absorption is so poor that the materials are no available, we cannot hope to build strong teeth. The beginnings o eeth are formed before the baby is born so the food of the mother nust contain liberal amounts of these minerals to give the baby a ood start. After birth the choice of the right food will supply the alcium and phosphorus necessary for the further development of he teeth.

Fluorine is found naturally in the water in many parts of the vorld, e.g., India, England, U.S.A. and Canada. When this water ontaining fluorine is used as drinking-water, the fluorine is deosited in both bones and teeth. In the teeth it may show as a faint iscolouration associated with an increased hardness in the enamel nd a resistance to dental caries. If there is too much fluorine, the iscolouration becomes very pronounced and a condition called mottled enamel" appears. In these cases the enamel becomes itted and decay follows rapidly. It is evident then that there is an mount of fluorine which is beneficial to tooth development, but hich, if it is overstepped, will cause discoloured teeth and rapid ecay.

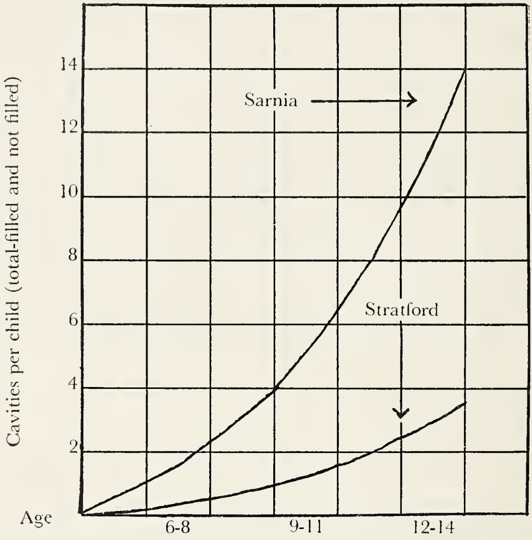
Fluorine is also found in minute amounts in food. It has been stimated that a normal mixed diet averages from 0.1 to 0.3 parts er million (p.p.m.) daily.

Since fluorine is a toxic substance if taken in too great amounts, is important to find the amount of fluorine that will harden the namel of the teeth and not cause injury to the individual. In the nited States, a great deal of research work has been done along ese lines with the result that one part per million in the drinkingater is considered non-toxic and at the same time useful in mbating dental caries.

In Canada, Brantford was the first city to add fluorine to the inking-water as a public health measure. Since fluorine is useful ainly during the growing period, the final results, measured in rms of dental caries, will not be known until all the teeth have upted.

In Stratford the water supply normally contains 1.3 parts per illion of fluorine. Dental examinations there seemed to show that e tooth decay rate was lower than in other places, so the national authorities in conjunction with the provincial and civic authoriti planned a large-scale survey. This survey includes three cities Stratford with fluorine appearing naturally in the water, Sarn with no fluorine in its water supply, and Brantford with the fluori

FIGURE 34. TOOTH DECAY IN TWO CANADIAN CITIES



Sarnia — no fluorine in water
Stratford — 1.3 p.p.m. fluorine in water.

Canada's Health and Welfare 5, 1949

added to its water supply. An interim report on dental caries Stratford and Sarnia is shown in Figure 34.

Looking at the graph above, it will be noticed that in Sarn where the drinking-water contains no fluorine, the number cavities per child increases rapidly with age until in the 12-14-ye age group there are 14 cavities per child (filled and not filled).

Stratford, on the other hand, although there is a slight increase in the number of cavities, in the 12-14-year age group, there are less than 4 cavities per child (filled and not filled). The Stratford children had about 65% less decay in their permanent teeth than the children of Sarnia.

This is a great reduction, but it does not mean that fluorine is the final answer to tooth decay. There are other factors of importance too.

2. Vitamins A, D, and C. These three vitamins are all of mportance in the formation of good strong teeth. Vitamin A is necessary for the proper development of the enamel. Vitamin D aids in the deposition of calcium and phosphorus in the teeth and vitamin C is necessary for the growth of the odontoblasts. It will be remembered that the most delicate test for a vitamin C deficient diet in the guinea-pig is an examination of the odontoblast cells of he teeth.

3. Sugar and Acid. Caries or decay is the result of bacterial action on the substance of the tooth. It begins in the enamel and hen spreads to the other tissues. Bacteria found here are the acid-orming type which act if there is soluble carbohydrate present. It has been proved that a minute or two after sugar is eaten, an acid medium develops and may be maintained for about an hour finally being neutralized by the saliva. Since a strong acid will attack and dissolve the enamel, it is most important to have the teeth kept as ree as possible from soluble carbohydrates. Brushing the teeth after ating and particularly after eating candy or sweets of any kind would be most helpful. If this is impossible, rinse the mouth out well with water to remove all particles that may be lodged in the teeth. A temporary restriction in the use of sweets would reduce the oral acterial count and caries activity. The immunity induced by this method lasts for a few months even after the individual has returned o a moderate use of sweets.

Good nutrition builds good teeth and makes them less susceptible o dental caries. Poorly developed teeth will be attacked by acid and broken down much more readily than if the teeth were wel formed to start with.

EXERCISE

What are the reasons that tooth decay is so widespread in 12-1 year-old children?

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Chapter 13.

FOOD FOR THE MOTHER AND BABY

Vital Statistics

The vital statistics of any country will show that the period of eproduction in the life of a woman is one of risk since pregnancy nd lactation make great demands on the body. However, in Canada ve are most fortunate as the figures for infant and maternal nortality show a consistent drop in numbers through a 30-year eriod. The 1954 *Canada Year Book* gives the following statistics:

ABLE 18. SUMMARY OF VITAL STATISTICS 1921-51

CANADA	INFANT MORTALITY (under one year of age)		MATERNAL MORTALITY	
	No.	*Rate**	*No.*	*Rate**
ve. 1921-25	24,337	98	1226	5.0
" 1931-35	17,101	75	1153	5.0
" 1941-45	15,093	55	791	2.9
" 1951	14,584	38	405	1.1

*per 1000 live births.

The improvement shown by the above table is due partly to ncreased public health measures and an extension of nursing care, ut also reflects a growing awareness of the need for adequate utrition. A study of 400 women planned and carried out by Dr. isdall and his co-workers at the Toronto General Hospital in 1941 nply proves this.

The study was undertaken to determine the effect of good and oor prenatal diets upon the outcome of pregnancy. The patients ere divided into three groups according to their diets. One group ate a poor diet of their own choosing all through pregnancy; th second group normally ate a poor diet but consented to add to i supplements supplied by the doctor which gave the diet an excellen rating; the third group ate a very good diet normally and were als advised by their doctor concerning their food habits.

The results left no room for doubt. Those who ate the "Supplemented—Good" diets were better obstetrical risks than those on th "Poor" prenatal diets. The incidence of miscarriages, still birth and premature babies was much increased in the "Poor" diet grou as were illnesses in babies after birth in comparison with the "Supplemented—Good" diets. Since then many other studies show striking parallel between the prenatal diet of the mother and th health of both mother and child.

Food for the mother during pregnancy and lactation will b discussed under four headings: (1) calories, (2) protein, (3 mineral matter and (4) vitamins.

1. Calories. There was an old belief that the mother should e for two; this led to difficulties particularly during pregnancy whe a great increase in weight is undesirable. There should be n increase in the normal calories consumed during the first half pregnancy and only a 500-calorie increase in the last few month This increase should be in food that will give protein, mine matter and vitamins as well. An example would be:

1 pt. milk (2½ c.)	383 calories	490 calori
1 egg	72 "	
1 serving of green- or yellow-coloured vegetable	35 "	

During lactation, the need is greater because the mother has make the milk secreted, which means work on the part of t mammary glands, and then there is the calorie value of the mi itself to be considered. These demands are of course over a above the normal energy needs of the individual woman. T increase in requirements will probably be met by adding 10 calories to the normal diet (500 calories more than she need during the last few months of pregnancy). Here again, the added food should yield protein, mineral matter and vitamins as well as the calories required. Since the composition of cow's milk is similar to that of mother's milk, it is used very economically by the mammary glands, and should be at a high level in the diet of the mother. During lactation, it is recommended that at least 3 cups of milk should be added to the diet over and above her normal consumption, which is presumably 2 cups. This makes 5 c. or 1 quart of nilk daily.

2. Protein. During both pregnancy and lactation, there is a pecial need for protein. In pregnancy the growth of the new baby equires it, and during lactation, the protein of mother's milk must e made. An increase of 25 grams is considered sufficient to meet hese extra needs. This intake is easily met by the increase in milk nd eggs.

3. Mineral Matter. Since the skeleton of the baby develops apidly, the need for extra calcium and phosphorus to build bones nd make the beginnings of the teeth is self-evident. Later on, the ninerals are needed in the manufacture of mother's milk.

There is need for liberal amounts of calcium both before and after irth. It is believed that the calcification of teeth prior to birth is airly homogenous and dense; and that the enamel and dentine ormed during the first 3 months of life is better calcified than that ormed during the subsequent 6 months. It is also true that the food aten after the eruption of teeth has a deciding influence on the roduction of dental caries. This was proved during the Second Vorld War, when food was rationed and the sugar content of the iet was low. The teeth of the children in Norway and the United Kingdom were much freer from decay than before the war. A urther discussion of dental health is included in Chapter 12.

The calcium requirement is not a fixed one since it will vary epending on previous food habits and reserves in the body. As an verage, however, the standard is about 1 gram calcium extra at his period.

The iron content of the infant at birth appears to depend upon the maternal intake during pregnancy. Since the baby is bor with a store of iron, under favourable conditions, extra iron shoul be included in the diet of the mother. An increase of 3 mg. i recommended daily.

4. Vitamins. Possibly the most important vitamins at this tim are vitamins D and A. The calcium and phosphorus in the diet ca be used efficiently only if vitamin D is present. Since cases of well developed rickets have been found in month-old infants of mal nourished mothers, it is important to take 400 IU of vitamin I daily. This should be in the form of fish-liver oil or capsules. Som form of fish-liver oil is desirable as it contains vitamin A as well Animal experiments show the value of vitamin A storage in th mother especially during the prenatal period. Green- or yellow coloured vegetables should be eaten liberally at this time. Th Canadian standard is an extra 2000 IU of vitamin A daily.

Since the calories are increased, there should be an automati increase in the three B vitamins, e.g., thiamine, riboflavin and niaci in proportion to the increase in calories recommended on p. 118.

The following table summarizes the Canadian standards durin the reproductive period.

TABLE 19. INCREASE OF NUTRIENTS ABOVE NORMAL DURING THE REPRODUCTIVE PERIOD

	CAL.	PROT. gr.	CALC. gm.	FE. mg.	VIT. A. IU	THIA. mg.	RIBO. mg.	NIACIN mg.	VIT. D IU
Pregnancy	500	25	1.0	3	2000	.15	.2	1.5	400
Lactation	1000	25	1.0	3	2000	.30	.5	3.0	400

Although it is of interest to understand the needs of the body this time, it is more important to be able to apply the information i a practical way.

To supply these increased needs as well as the normal needs the body, it is necessary to use the foods suggested in Canada's Foo

Rules, p. 2, and add more in some groups. Here are the foods that should be eaten daily to supply the building materials:

Milk: 1 quart (5 c.) and cheese occasionally.
Fruit: at least 2 servings—one a citrus fruit or tomatoes.
Vegetables: potato, 1 green or yellow, 1 raw and 1 other veg.
Cereals: whole-grain including whole-wheat bread with either margarine or butter.
Meats: 1 serving daily and liver once a week.
1 egg daily and sometimes 2.
Cod-liver oil: 1 teaspoon.

The foods listed above will supply the protein, mineral matter and vitamins needed at this time, but the calories may not be sufficient. It depends entirely upon how these foods are used. For instance, if an apple is eaten raw, it supplies 60 calories, while if eaten in the form of apple pie, it supplies 246 calories. Again, if the pie is eaten with cheese, the probable calorie value will be 350.

As will be seen by this example, the amount of flour, sugar and fat used to make the above foods palatable will vary with the individual tastes and also with the individual needs. A large woman who does her own household work needs many more calories than a small woman who has household help. The foods listed above are of great importance and should form the basis of all menus at this time. More of these foods may be used if desired, but the amount should not be reduced except by the doctor's orders.

Human Milk and Cow's Milk

This chapter would not be complete without a very brief discussion of the difference between human milk and cow's milk. It should be remembered that the human infant grows more slowly than the young of any other species. It takes about 180 days to double its weight, while the calf takes only 47 days. Since nature normally supplies the milk best suited to the growth of the young, it means that the composition of human milk must be different from that of cow's milk. This is the main reason why doctors urge breast-feeding. The baby receives the food nature has prepared for it and in a sterile form.

The milk secreted by the mammary glands during the first ten days is called colostrum and is different in composition to the later milk called mature milk. Colostrum has slightly more protein and less fat and lactose than mature milk. Table 20 shows the composition of mature human milk and cow's milk.

TABLE 20. COMPOSITION OF HUMAN AND COW'S MILK IN 100 GRAMS

	CALORIES	PROTEIN gm.	FAT gm.	CARBOHYDRATE gm.	CALCIUM gm.
Human Milk (Mature)	71	1.2	3.8	7.0	.034
Cow's Milk	65	3.5	3.5	4.9	.118

Milk Formulas

Unfortunately there are some mothers who cannot nurse their own babies and so cow's milk is used. It must be modified to make it suitable for the infant's digestive tract and sterilized so that the baby will not be exposed to disease germs.

Whole fluid milk, evaporated milk and dried milk are all used in making infant formulas today. With care in the preparation and handling of the milk, there is no reason why the baby should not be adequately and safely nourished. Both water and sugar are usually added. The proportions of milk, water and sugar are carefully worked out by the doctor to suit the requirements of the individual infant. An acid-milk formula is used for some children who have digestive difficulties since it is easily digested and also increases the acid in the duodenum, thereby aiding in the absorption of calcium and iron.

Other Foods for the Infant

As well as the milk formula, the baby should receive both orange juice (to prevent scurvy) and fish-liver oil (to prevent rickets) very early in life. Orange juice should be started with a teaspoon diluted with the same amount of water. It should gradually be increased until the baby is taking the juice of half an orange undiluted daily. Fish-liver oil should be started at birth with a few drops from a medicine dropper. It should be increased gradually to 400 IU of vitamin D daily (1-2 teaspoons).

As soon as he is accustomed to orange juice and cod-liver oil, he should receive some cereal. At first it is sieved and diluted with milk, but gradually he will become accustomed to its ordinary texture and thickness and by the time he is six months old, he should be able to eat the cereal the rest of the family are eating as long as it is well cooked. The amount needed is variable and depends somewhat upon the amount of fruit and vegetable in the diet as these three are all somewhat laxative in effect. Vegetable and fruit pulp should be given early and in small amounts until the different tastes are well established. Sieved meat may be given at six months and egg yolk is well tolerated by most infants before that.

EXERCISE

Use the foods listed on p. 121 and write a week's menus for an expectant mother. Use attractive low-cost foods.

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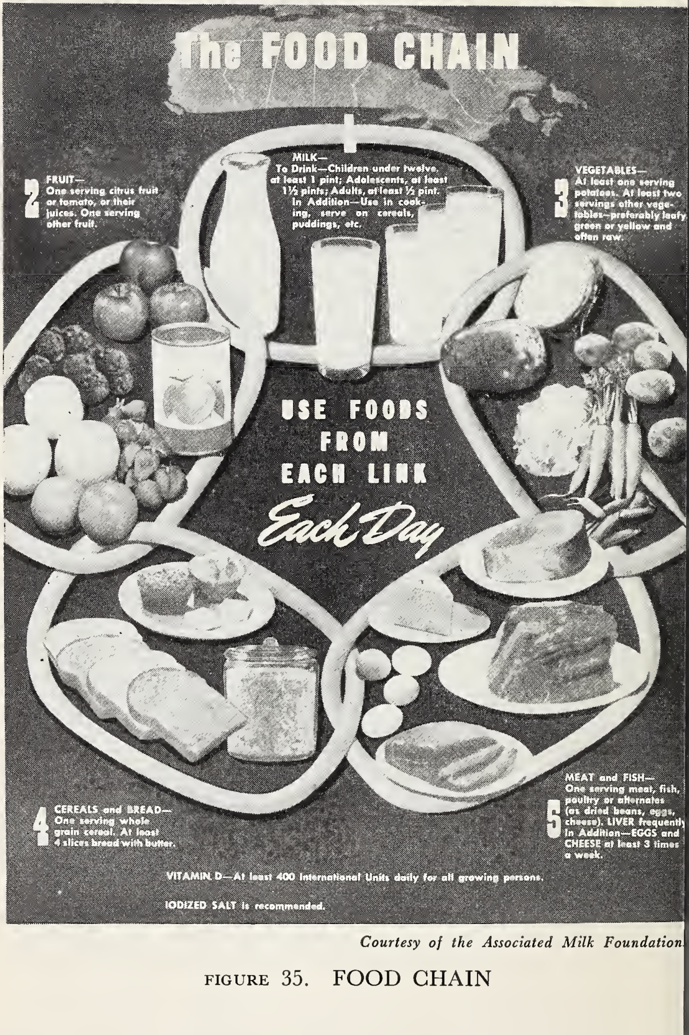

The FOOD CHAIN
USE FOODS FROM EACH LINK
Each Day

MILK—
To Drink—Children under twelve, at least 1 pint; Adolescents, at least 1½ pints; Adults, at least ½ pint. In Addition—Use in cooking, serve on cereals, puddings, etc.

2 **FRUIT—**
One serving citrus fruit or tomato, or their juices. One serving other fruit.

3 **VEGETABLES—**
At least one serving potatoes. At least two servings other vegetables—preferably leafy, green or yellow and often raw.

4 **CEREALS and BREAD—**
One serving whole grain cereal. At least 4 slices bread with butter.

5 **MEAT and FISH—**
One serving meat, fish, poultry or alternates (as dried beans, eggs, cheese). LIVER frequently. In Addition—EGGS and CHEESE at least 3 times a week.

VITAMIN D—At least 400 International Units daily for all growing persons.

IODIZED SALT is recommended.

Courtesy of the Associated Milk Foundation

FIGURE 35. FOOD CHAIN

Chapter 14.

FOOD FOR CHILDREN AND ADOLESCENTS

While the child is growing, it is important to have a liberal supply of calories. This is necessary for three reasons: (1) the basal metabolic rate is still higher than that of an adult per unit of weight, (2) activity is very great, and (3) unless the calories are iberal, some of the protein which should be used in building the body will be burned as fuel. This is particularly important in adolescence.

There must be enough calories to take care of fuel needs. But calories alone would soon create problems. Fortunately, most foods provide building materials—protein, mineral matter and vitamins—along with calories. A brief discussion of the nutritive value of the various food groups with the amounts recommended follows. The younger child will need the smaller amounts while the adolescent will need the larger amounts recommended and possibly more.

In discussing the nutritive value of the following foods, only those nutrients that are contained in fairly liberal amounts are mentioned. There are, of course, other nutrients present, but in smaller amounts.

Milk: (*Valuable mainly for protein, calcium and riboflavin*)

Milk is a most valuable food. Although it is 87% water, it contains, dissolved in the water, protein, calcium and riboflavin in ubstantial amounts. The proteins, casein and lactalbumin, contain a large supply of the essential amino acids and are therefore particularly suitable for growing children and adolescents. It would be very difficult, if not impossible, to supply the calcium needs of children without milk (see Figure 11). The liberal amounts of riboflavin in milk are shown by a comparison of the different foods hat contain the same amount as found in ½ c. milk (see Figure 30).

Milk may be obtained in different forms such as evaporated milk, dried milk, chocolate milk and fermented milk. There is very litt loss of the three nutrients—protein, calcium and riboflavin—in a of these forms, whether they are made from skimmed milk or who milk. These three nutrients are dissolved in the non-fat part of mil

Evaporated milk has 480 IU of vitamin D added to every 15-o tin and so it is better than fluid milk on that count. The flavour not usually liked as well as that of fluid milk, so it is not us very much except in infant formulas and in cooking.

Chocolate milk has had a little fat removed (the law reads th it must contain not less than 3 per cent milk fat), and both sugar a cocoa added. The result is a slight increase in calorie valu One-half pint (10 ounces) of whole fluid milk gives 190 calori while the same amount of chocolate milk gives 220 calories. T amount of protein, however, remains the same in both—10 grams protein per ½ pint. The riboflavin also remains the same in bot Cocoa and chocolate contain oxalic acid which will unite wi calcium to form calcium oxalate. This oxalate is insoluble and prevents absorption of the calcium so held. However, the amou is very small indeed. One-half pint of chocolate milk contains 0.3 grams calcium of which only 0.009 grams may be bound by t oxalic acid.

The addition of sugar creates a problem in relation to too decay. It is a fact that one of the causes of tooth decay is t formation of acid from soluble carbohydrate by bacteria in t mouth, so that when chocolate milk is taken it supplies solu carbohydrate as food for the bacteria.

On the whole, it should be remembered that chocolate mi supplies the same protein and riboflavin that is found in ordina milk and almost as much calcium. It is much better to ta chocolate milk than no milk at all, but ordinary milk would redu the chances of tooth decay.

Fermented milks are made by fermentation, using bacilli th change milk sugar, lactose, to lactic acid. They include buttermil acidophilus, koumiss and yogurt. Some people prefer the acid tast and find it useful in combating constipation.

COMPARISON OF RATS ON TWO DIETS

(1) Whole-wheat bread and milk.

(2) Whole-wheat bread and a carbonated beverage.

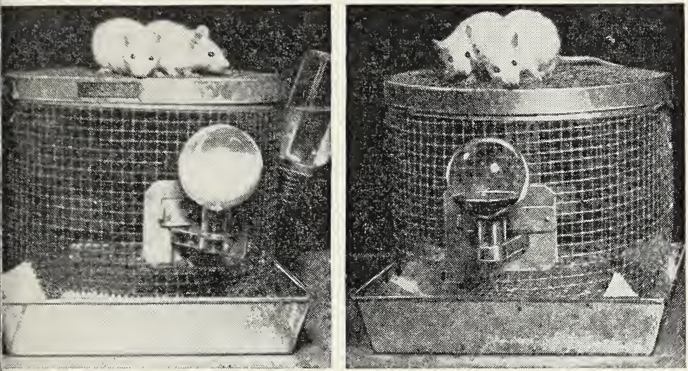
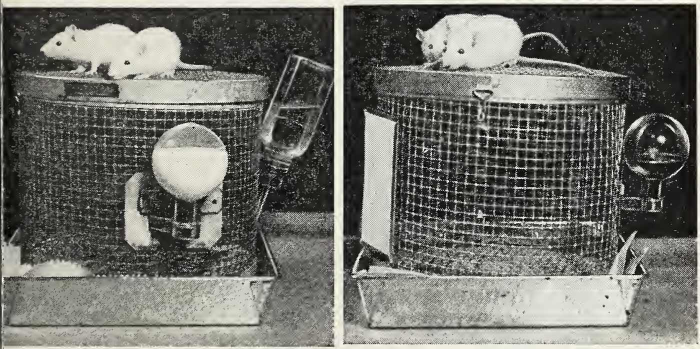


FIGURE 36A. Appearance at start of experiment.

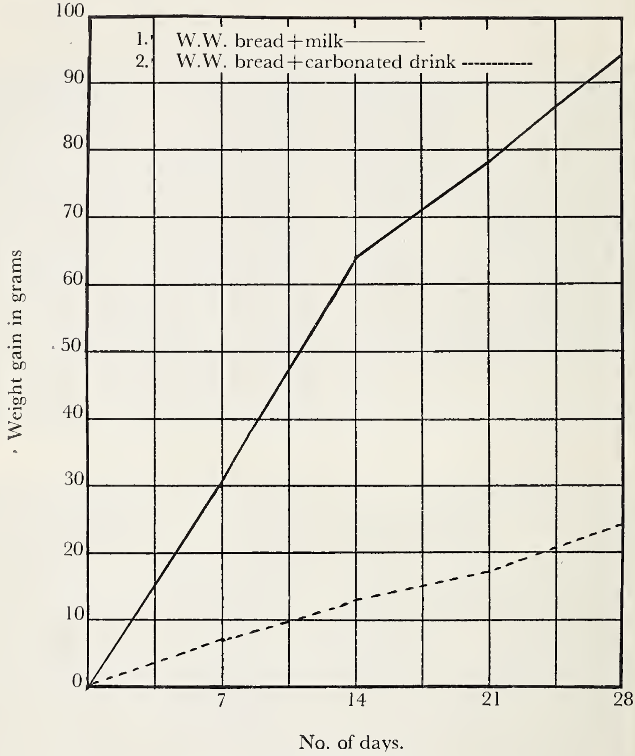


University of Manitoba, 1955

FIGURE 36B. Appearance after 4 weeks on diets.

Ordinary cheddar cheese and processed cheese, which are just other forms of milk, also contain the protein, calcium and riboflavin found in the original milk from which they were made. Cottage cheese, however, has lost some calcium in its manufacture. *Recommendation:* 3-5 cups daily.

FIGURE 37. GRAPH OF GROWTH OF RATS ON TWO DIET



GROWTH OF RATS IN 4 WEEKS FED
(1) WHOLE-WHEAT BREAD+MILK AND
(2) WHOLE-WHEAT BREAD+A
CARBONATED DRINK

In 28 days the rats on whole-wheat bread and milk gained 95 grams while the rats on whole-wheat bread and a carbonated beverage gained only 25 grams.

University of Manitoba, 1953

Fruits: (*Valuable mainly for ascorbic acid and cellulose*)

Fresh fruit contains about 75% - 85% water and when dried the water content is reduced to about 25%. There is some ascorbic acid in all fresh fruit, but the best sources are the citrus fruits—oranges, grapefruit, and lemon. All fruit, fresh or dried, contains cellulose or bulk. Fruit for breakfast every morning stimulates the muscular movements of the digestive tract and helps to develop good habits of elimination.

Recommendation: 2 servings of fruit daily—one a citrus fruit.

Vegetables: (*Valuable mainly for vitamin A and cellulose*)

The two parts of the vegetable that are commonly used for food are the root and the leaf. If these are green or yellow, they are very good sources of carotene or provitamin A. They also contain cellulose and act as a "broom" in the intestinal tract. Potatoes are in a class by themselves as they supply calories and ascorbic acid but no vitamin A.

Dried peas and beans (legumes) have been so changed by the process of drying that they should be included in the section on meat as a meat substitute or alternate.

Recommendation: Potatoes, once a day; green or yellow vegetable, once a day and one serving of another vegetable.

Cereals and Bread: (*Valuable mainly for calories, B-complex vitamins and for cellulose when whole-grain products are used*)

The principal cereals used in Canada are wheat and oats although small amounts of rice, corn, barley and rye are also used. In Canada, nearly ⅓ of the total calories consumed comes from cereals. In 1953 "enrichment" of white flour was allowed in Canada. For a full discussion, see pp. 93–7. This means that thiamine, riboflavin, and niacin are found in appreciable amounts in white bread and in any baked products using white flour. These three parts of the B-complex vitamins, and any others normally present in the whole grain, will be found in whole-wheat bread or in rolled oats. Since a hot cereal should be eaten for breakfast in the winter, this is a good time to serve rolled oats or any whole-grain cereal. Whole-grain cereals help, along with fruits and vegetables, to stimulate peristalsis.

Recommendation: 1 serving rolled oats or any whole-grain cereal as breakfast cereal. 2-4 slices bread, at least half as whole wheat.

Butter and Margarine: (*Valuable for calories and Vitamin A*)

Butter and margarine have the same nutrient value. They are excellent sources of calories and of vitamin A. The vitamin A content of butter varies somewhat with the season of the year, while the amount in margarine is constant—16,000 IU per pound. This is based on the average amount found in butter. The calorie value of both is high since they are fats.

Recommendation: 2-4 tablespoons.

Meat, Fish or Meat Alternates: (*Valuable for protein, some B-vitamins and iron*)

Meat, fish and poultry are very much alike in composition. The protein is about 20% of the whole, while the fat and water content will be variable depending on the part of the animal used. Pork contains more fat than most meats, as well as liberal amounts of thiamine. Beef, on the average, has less fat than pork, and little thiamine, but contains substantial amounts of riboflavin and niacin. Liver is a veritable storehouse of vitamins including the fat-soluble which are found nowhere else in the body. The meat alternates are cheese, eggs and legumes. These are all useful additions to the diet. Eggs and legumes as well as beef give liberal amounts of iron.

Recommendation: One serving of meat, fish, chicken, or a meat alternate every day. Serve liver once a week. One egg daily for adolescents particularly.

Sugar: (*Valuable for calories only*)

Sugar is a good energy food if used in moderation. It should be restricted in the diet of young children and allowed for older children and adolescents after the essential building foods have been adequately supplied. It should normally be served in the form of a dessert. For information on sugar and teeth, see Chapter 12.

Sample menus for two weeks are found on pp. 131-3.

TABLE 21A. SAMPLE MENUS

(Courtesy of Nutrition Division, Department of National Health and Welfare)

Breakfast	*Lunch or Supper*	*Dinner*
Prunes Cracked Wheat Sugar and Milk Whole Wheat or Canada Approved Toast Jam	Creamed Peas on Toast Orange Custard Cookies Milk (children)	Pot Roast of Beef Baked Potatoes—Gravy Creamed Cabbage Indian Pudding Tea—Milk (children)
Tomato Juice Rolled Oats Sugar and Milk Whole Wheat or Canada Approved Toast Marmalade	Split Pea Soup Toasted Cheese Sandwiches Sliced Bananas Cookies Milk (children)	Cold Roast Beef Scalloped Potatoes Green Beans Cottage Pudding with Vanilla Sauce Tea—Milk (children)
Cracked Wheat Sugar and Milk Whole Wheat or Canada Approved Toast Jam	Spaghetti with Tomato Sauce Bread and Butter Prunes—Cookies Milk (children)	Braised Liver Baked Potatoes Creamed Onions Peas Chocolate Blanc Mange Tea—Milk (children)
Half Grapefruit Whole Wheat Griddle Cakes Syrup	Hard Cooked Egg Potato Salad Bread and Butter Chocolate Blanc Mange Milk (children)	Baked Beans Carrots—Cabbage Salad Bread and Butter Apple Pie Tea—Milk (children)
Tomato Juice Rolled Oats Sugar and Milk Whole Wheat or Canada Approved Toast Marmalade	Welsh Rarebit on Toast Raw Carrot Strips Sliced Bananas Cookies Milk (children)	Fried Haddock Mashed Potatoes Glazed Turnips Bread Pudding with Raisins Tea—Milk (children)
Cracked Wheat Sugar and Milk Poached Egg on Whole Wheat or Canada Approved Toast	Scalloped Potatoes Peanut Butter Sandwiches Bran Muffins—Jam Milk (children)	Hamburger Patties Boiled Potatoes Canned Tomatoes Parsnips Prune Jelly—Cookies Tea—Milk (children)
Tomato Juice Rolled Oats Sugar and Milk Whole Wheat or Canada Approved Toast Jelly	Jellied Vegetable Salad Cheese Bread and Butter Apple Brown Betty Milk (children)	Beef Stew with Vegetables and Dumplings Boiled Potatoes Bread and Butter Vanilla Blanc Mange Cookies—Tea—Milk (children)

TABLE 21B. SAMPLE MENUS

Breakfast	*Lunch or Supper*	*Dinner*
Tomato Juice Oatmeal Sugar and Milk Canada Approved Toast Marmalade	Scrambled Egg Cabbage and Carrot Salad Whole Wheat Bread and Butter Sliced Banana Milk (children)	Baked Sausages Mashed Potatoes Harvard Beets Whole Wheat Bread and Butter Baked Custard Tea—Milk (children)
Tomato Juice Cracked Wheat Sugar and Milk Canada Approved Toast Jam	Spaghetti and Tomatoes in Cheese Sauce Whole Wheat Bread and Butter Prunes Matrimonial Cake Milk (children)	Liver and Onions Boiled Potatoes Buttered Carrots Whole Wheat Bread and Butter Tapioca Pudding Tea—Milk (children)
Sliced Orange Oatmeal Sugar and Milk Canada Approved Toast Marmalade	Toasted Cheese Sandwiches Raw Turnip Sticks Baked Apples Peanut Butter Cookies Milk (children)	Salmon Loaf Baked Potatoes Peas Whole Wheat Bread and Butter Steamed Carrot Pudding with Orange Sauce Tea—Milk (children)
Tomato Juice Cracked Wheat Sugar and Milk Canada Approved Toast Jam	Cold Salmon Loaf Potato Salad Whole Wheat Bread and Butter Rice Pudding Milk (children)	Baked Beans with Tomato Sauce Spinach Whole Wheat Bread and Butter Banana Jelly Oatmeal Squares Tea—Milk (children)
Half Grapefruit Oatmeal Sugar and Milk Canada Approved Toast Jam	Cabbage Salad Carrot Strips Whole Wheat Bread and Butter Tea Biscuits—Cheese Banana Whip Oatmeal Squares Milk (children)	Meat Loaf Baked Potatoes Buttered Carrots Whole Wheat Bread and Butter Raisin Pie Tea—Milk (children)

TABLE 21B—*continued*

Cracked Wheat Sugar and Milk Canada Approved Toast Jelly	Baked Beans Whole Wheat Bread and Butter Raisin Pie Milk (children)	Swiss Steak with Onions and Tomatoes Boiled Potatoes Peas Canada Approved Bread and Butter Muffins and Jam Tea—Milk (children)
Tomato Juice Oatmeal Sugar and Milk Canada Approved Toast Jam	Macaroni and Cheese Whole Wheat Bread and Butter Apple Sauce Peanut Butter Cookies Milk (children)	Lamb Patties Mashed Potatoes Mashed Turnips Diced Beets Whole Wheat Bread, Butter Queen's Pudding Tea—Milk (children)

School Lunch

Every school, where there are pupils who do not go home for lunch, has an obligation at least to provide a suitable room where the lunch can be eaten. It is better to provide one hot dish, preferably made with milk, and better yet to have facilities where children can buy a full meal at low cost.

An adequate noon meal is indispensable if the child is to be properly nourished. It should consist of milk, fruit or raw vegetable, bread and butter, and meat or meat alternate.

If a full lunch has to be carried from home, sandwiches will, of course, form the major part of the lunch. In that case, the use of different kinds of breads may make the lunch more attractive. Rye bread, whole-wheat, raisin or steamed brown bread make a welcome change. A thermos will be useful to carry milk and a small tight-lidded jar could be used for salads or puddings or stewed fruit.

There are many excellent leaflets and bulletins on school lunches published both by the Nutrition Division, Department of National Health and Welfare, and by provincial Departments. A few of the many are listed in the references at the end of this chapter.

EXERCISE

Plan a day's menu for a child of 6 years using 3 cups of milk, of which at least half is in cooked form.

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Chapter 15.

FOOD FOR OLDER PEOPLE

Since the end of the First World War, there has been a great increase in the number of years that Canadian men and women may expect, on the average, to live. The *Canada Year Book,* 1954, states that in 1921, the average age of death (females) was 41.1 years. However, if born in 1947, she can reasonably expect, on the average, to live to be 71 years of age. The "life expectancy" of men is of the same order.

The fact that men and women are living longer presents many problems to the community in which they live. If they are to lead a happy, contented life, they must be made to feel that they are needed and that the work they can do is useful. They must, of course, be properly fed either by relations or in institutions.

Presumably by proper feeding the onset of old age can be delayed. It is a known fact that one person at 50 is as old, if not older, in physical and mental abilities, as another person at 70 years of age. Some research work has been done to establish the requirements of older people although there is a great deal more to be done.

Calories

There is a decreased need for calories for two reasons: (1) the basal metabolic rate (BMR) is lower in older people, and (2) muscular activity is lessened. Since the need for calories has been lowered, it is increasingly important to choose the food wisely. Very little, if any, food should be eaten that is devoid of some building material, e.g., protein, mineral matter or vitamins. For some reason, not clearly understood, the older person who is slightly underweight, lives longer than the overweight person.

Building Materials

The need for building materials (protein, mineral matter and vitamins) has *not* been decreased, and, in fact, may possibly be increased. If there is difficulty in digestion and absorption, the need for a liberal intake of these nutrients is increased and the choice of food high in protein, mineral matter and vitamins becomes imperative.

Milk and eggs are the two protein foods that should be eaten liberally. As well as the protein, milk supplies the calcium needed to renew the loss from the bones, and eggs supply iron for the blood. Both milk and eggs furnish an appreciable amount of the necessary vitamins as well. Other protein foods like meat, fish, chicken are also very welcome in the diet and add to the supply of mineral matter and vitamins. If liver is enjoyed it should be eaten once a week.

Fruits and vegetables should be eaten liberally. Fruits should be used as desserts instead of pies and puddings and are usually well liked. The amount of cereal eaten will probably be reduced in old age since activity is lessened.

Canada's Food Rules, p. 2, become increasingly important in the older-age group as they show the foods necessary for health.

Digestion and Absorption

In the later years of life, there is a diminished ability to digest and absorb food. There is a slowing up of the muscular movements of the intestinal tract and a lessened activity of the digestive organs which secrete the digestive juices. This may mean difficulty in elimination. The use of laxatives, never very good at any time, is to be deplored, as absorption will be hindered. By choosing food carefully, atonic constipation can be overcome and natural habits of elimination restored.

There are two types of constipation: (1) atonic, which means lacking tone, or in other words insufficient muscular activity in the intestinal tract, and (2) spastic, which is caused by a muscular spasm, usually nervous in origin. Atonic constipation is the common type of constipation that can easily be cured by eating the right food and giving attention to proper hygienic habits as considered in Chapter 11. Spastic constipation is the reverse of atonic constipation since it is caused by a tightening of the muscular bands of the digestive tract. Proper treatment of this type of constipation must include some method of relaxing the tight muscles. Roughage, in the form of coarse cereals or whole-wheat bread, should be omitted from the diet as it would only aggravate the condition. This is important to older persons who in many cases suffer from spastic constipation.

Mild stimulants, like tea and coffee, are usually well liked by older people, and provide extra liquid. They sometimes improve digestion if used in moderate amounts. Hot beef broth to start a meal is good and is also a mild stimulant to the flow of digestive juices. Pickles, relishes, catsup and vinegar have little or no food value yet they stimulate the appetite and add to the enjoyment of the meal.

Rules to Follow

1. Eat less total food than formerly.
2. Eat smaller meals and more often.
3. Eat food that will give some building material as well as calories.
4. Do not eat fried food.
5. Cut down on the sugar content of meals.
6. Use simple foods that are easily digested.
7. Use milk and eggs liberally.
8. Use fruits and vegetables liberally to prevent atonic constipation.
9. Use whole-grain cereals as much as possible. Use only refined cereals if spastic constipation is present.
10. Use lean meats that have been broiled, stewed or roasted.

It will be noted that, in general, the food for older people is imilar to that for young children. It must be nourishing and appetizing and, above all, easy to digest. The basis of the diet also, as with children, is milk and eggs.

Food Fads and Fallacies

There are many incorrect ideas, relating to food and nutrition, that unfortunately are believed by a large number of people. They think these ideas are correct because they have been repeated s often and have been explained in pseudo-scientific language which sounds plausible.

One of the fallacies that was widespread a few years ago concerned the so-called "incompatibility" of carbohydrate and protein. Such common combinations as meat and potatoes were deplore since optimum conditions for digestion were different for thes two foods. It was never explained how the carbohydrate and protei in cereals were properly digested, if this were true, nor how legumes, containing both carbohydrate and protein, could be digested at all!

A very prevalent fallacy today is the idea that certain foods ar "fattening" and others are not. It is true that one can eat more o some foods, such as fruits and vegetables, than of others such a sugars and fats, to obtain a certain number of calories, but it is th total number of calories consumed, compared with what one needs, that will cause a gain in weight.

The term, acidosis, is often used incorrectly. In its true sense i means that the reaction of the blood has become slightly acid instea of being neutral or faintly alkaline which is normal. This is onl possible in an illness such as diabetes and in that case the individua needs the services of a doctor. In a normal person, acid-tastin foods like oranges and lemons increase the acid in the stomach, bu after digestion are so changed that they add to the alkaline reserv of the blood.

Unfortunately some advertisements tell a half-truth or by suggestion make an inference which is quite inaccurate in an endeavour t sell their product. This type of advertising is being discouraged b firms who have a reputation to uphold. It is only by intelligen study that the plausible fallacies foisted on a gullible public can be exposed. Nutrition information is now available from reputable sources and can be used to check such statements.

EXERCISES

1. Is the statement below correct?
1 ounce of gelatin contains as much protein as:
1 large beefsteak *or* 3 c. milk
or 4 eggs *or* ½ lb. bread.
Criticize the inference that is likely to be drawn from a statement such as this.
2. Collect several advertisements to discuss in class.

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Chapter 16.

WORLD FOOD NEEDS

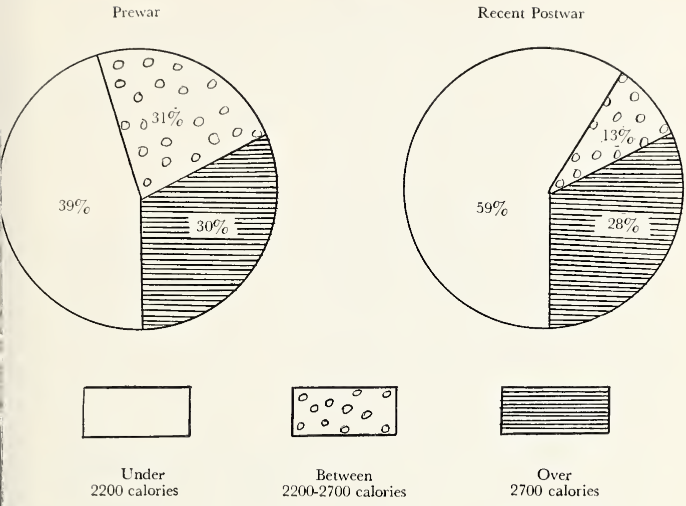
It is unfortunately a well-established fact that many people i the world today suffer from a lack of sufficient food. In man countries famine stalks the land whenever there is a crop failur and even when crops are good, there are many who live in a stat of semi-starvation with insufficient to eat.

In 1946 a world food survey was published based on pre-wa supplies in various countries of the world. It was hoped that b knowing the food supplies in the world, some estimate could b made of how much food should be available to prevent famine an promote health. Tentative estimates were set up and plans made t improve conditions. Again in 1952 a second world food survey wa made and published based on recent post-war supplies. The tw surveys are compared in Figure 38.

Extent of Need

It will be seen that instead of improving, the nutrition of th world has worsened. While in the pre-war period the percentage o the population receiving less than 2,200 calories per person per da was about 40 per cent, in the recent post-war period the percentag has risen to almost 60 per cent. The percentage of the populatio receiving over 2,700 calories has remained fairly constant at abou 30 per cent. But the percentage receiving between 2,200 and 2,70 calories per person per day has lessened in the post-war period. Thi is due to the fact that, unfortunately, some who were in this categor before the war have now dropped down to below 2,200 calories, thu swelling the numbers in the low-calorie group.

As would be expected, the well-fed part of the world is highl industrialized, and the poorest-fed sections are those that are mos underdeveloped.



Based on "Second World Food Survey", FAO. 1952.
(Approximately 80% of world population).

IGURE 38. DISTRIBUTION OF POPULATION ACCORDING TO NATIONAL AVERAGE SUPPLIES OF CALORIES

These figures are based on distribution of food at the retail level. Since there is loss and wastage before the food is ready to eat, the verage amount actually consumed per person per day would be ven less. Averages, of course, smooth away differences. There re great variations in the individual consumption of food, many ating much more than the average, and many eating less.

The reasons for this deterioration are not far to seek. The population of the world has increased in the intervening years, while roduction has not increased sufficiently to meet the demand. In act, in some parts of the world, production has dropped below the re-war level while population has increased as much as 10 per cent.

The greater increases in population are in the underdevelope countries of the world, creating a greater problem than ever.

Today diseases such as malaria are being controlled, and th population is increasing more rapidly than before. In fifty year the world population will probably be 4,000 million, or twice wha it was before World War II.

Improvement in World Conditions

To improve conditions in the underdeveloped regions of th world, there must be first of all greater production of food in thes areas. There is little new land to bring under cultivation, so th land in use must be cultivated more intensively. This can be accomplished by using better seed and more fertilizer, and by bette farming methods in general. Since some countries have surplu food which cannot find markets, there should be a World Foo Board to allocate surpluses to countries according to need.

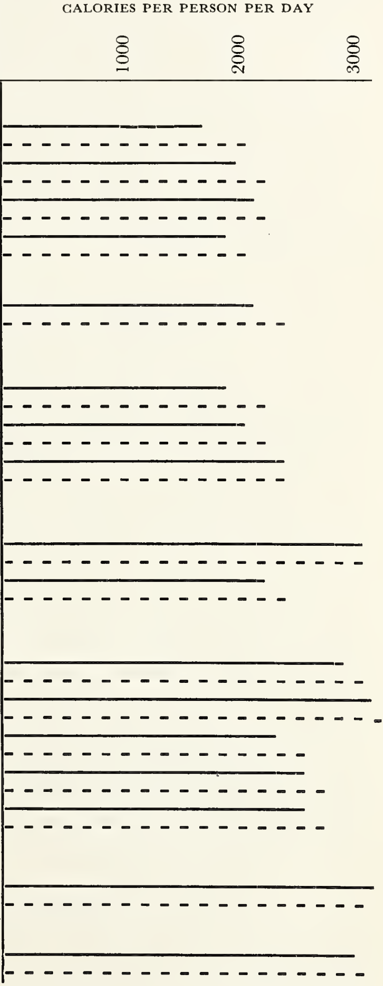
Under United Nations, there are three agencies which ar attempting to help the underdeveloped countries of the world. Thes are: Food and Agriculture Organization (FAO), World Healt Organization (WHO), and United Nations International Children's Emergency Fund (UNICEF).

There are other agencies as well whose chief aim is to hel countries develop their own resources. The Colombo Plan fo Co-operative Economic Development in South and Southeast Asi is a plan in which Canada is particularly interested. India, Pakista and Ceylon had evolved plans for their own development, but ha insufficient funds to develop them adequately. So some othe members of the Commonwealth, e.g., Australia, New Zealand, th United Kingdom and Canada, have helped in this development b giving both money and technical assistance. Canada has give $25,000,000 annually since 1950 and has increased this amount t $26,000,000 (1954) in order to give more assistance to new project developing in these countries and other countries in Southeast Asi which have joined the Plan. The United States also is now member of the Colombo Plan.

TABLE 22. CALORIE SUPPLIES (AT RETAIL LEVEL) PER PERSON PER DAY

(Based on "Second World Food Survey", Appendix 5, 1952)

REGIONS OF THE WORLD AND SUB-REGIONS	PERIODS: P.-RECENT POST-WAR T.-1960 TARGET
FAR EAST	
South Asia	P. 1770
	T. 2050
East Asia	P. 2000
	T. 2250
N. E. Asia	P. 2100
	T. 2210
Pacific Is. and Malay Pen.	P. 1900
	T. 2130
NEAR EAST	
	P. 2180
	T. 2370
AFRICA	
N. Africa	P. 1920
	T. 2290
Central Africa	P. 2080
	T. 2260
Southern Africa	P. 2420
	T. 2470
LATIN AMERICA	
River Plate Countries	P. 3090
	T. 3090
Rest of Latin America	P. 2250
	T. 2490
EUROPE	
Western Europe	P. 2950
	T. 3020
Northern Europe	P. 3120
	T. 3150
Southern Europe	P. 2350
	T. 2690
Eastern Europe	P. 2600
	T. 2700
Germany and Austria	P. 2600
	T. 2710
NORTH AMERICA AND OCEANIA	
	P. 3130
	T. 3110
U.S.S.R.	
	P. 3010
	T. 3060



Looking at Table 22, it will be noticed that a tentative target ha been set for all countries of the world. These targets are differen from each other. In the best-fed countries of the world, the targe is about the same as the recent post-war figures. In the low-calori countries a start has been made by putting the target about 15 pe cent higher than the recent post-war figures.

Although this discussion has been centred round the proble of total calories or quantity of food, it will be apparent that wher calories are low there will be a deficiency of protein, mineral matte and vitamins as well. The first and greatest problem to solve, then is the problem of calories.

"Original" *vs.* "Animal" Calories

(Primary vs. Secondary Calories)

Original calories are the calories obtained from primary source and include cereals, vegetables, fruits and fish. Animal calories, on the other hand, are those calories that we receive from animal sources and include milk, eggs, beef, chicken, pork etc. To obtain animal calories, we must feed original calories to the animal and by so doing, we reduce the calorie value enormously. For instance, by feeding wheat to a pig, we use approximately 1,500,000 calories in the form of wheat, and only receive 300,000 calories in the form of pork. In other words, it takes 5 calories of wheat to produce 1 calorie of pork. Other animals are less efficient, and the loss is greater.

This problem is not all one-sided. Along with the animal calories, valuable protein, mineral matter and vitamins are found. These are all necessary for good health. What should be the best proportion of original and animal calories for the welfare of the world? Perhaps science will have the answer.

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GLOSSARY

Adaptometer, instrument to measure the ability of the eye to adap itself to changes in the intensity of light.

Assay, test to determine quantity.

Atherosclerosis, a senile type of arteriosclerosis characterized by th fibrous thickening of the inner coat of blood vessels.

Atonic, without tone.

Basal Metabolic Rate (BMR), smallest number of calories on which an individual can exist.

Beri-beri, a disease caused by a lack of thiamine.

Bioassay, test by using an animal.

Calciferol, a form of vitamin D.

Calorimeter, instrument to measure calories.

Carotene, provitamin A, vegetable form.

Cassava, tapioca.

Cholesterol, a fatty substance found chiefly in the bile but also i other parts of the body. It is found in some foods, e.g. egg-yolk When irradiated it forms vitamin D.

Citrovorum factor, active form of folic acid.

Collagen, a substance present in connective tissue, bone and cartilage When properly developed it is called "mature collagen".

Colostrum, first milk.

Cornea, part of the eyeball which admits light to the interior.

Dental caries, tooth decay.

Dicoumarol, anti-vitamin K. Prevents blood clotting.

Duodenum, name given to the first 12 inches of the small intestine

Ergosterol, provitamin D.

FAO, Food and Agriculture Organization of United Nations.

Ferritin, storage form of iron.

Fluorescence, emitting radiation.

Glycogen, stored form of starch in animal body.

Kwashiorkor, disease caused by lack of protein.

Menadione, synthetic vitamin K.

Microgram, one-thousandth part of a milligram.

Neonatal, first ten days of life.

Odontoblasts, cells which line the pulp chamber of the tooth.

Osmotic pressure, the force with which a solution enclosed in a semi-permeable membrane attracts water.

P.p.m., parts per million.

Pellagra, disease caused by lack of niacin.

Peristalsis, muscular movements of the digestive tract.

Physiological fuel value, calorie value of food inside the body.

Polyneuritis (**beri-beri**), disease caused by lack of thiamine.

Precursor, that which precedes.

Prenatal, before birth.

Provitamin, inactive form of vitamin.

Pulses, legumes.

Rachitic rosary, a row of beading at the junction of the ribs with their cartilages. It is found in children suffering from rickets.

Radius, the outer and shorter of the two bones of the forearm.

Retina, lining of the posterior chamber of the eye.

Saturation, filled as much as possible.

Scotometry, measure of the scotoma of the retina.

Skin-fold technique, a method of measuring fatty tissue by means of calipers.

Spastic, pertaining to a spasm.

Spectrometer, measure of wave-lengths of light.

Synthesis, building up a compound out of simpler elements.

Thiochrome, a quantitative colorimetric method for the assay of thiamine.

Thyroxine, active principle of the thyroid gland.

Tiki-tiki, extract of rice polishings.

Villus (plural **villi**), one of the minute finger-like processes lining the small intestine.

Viosterol, a form of vitamin D.

X-ray, revealing the internal structure of opaque objects.

Xerophthalmia, disease of the eye caused by lack of vitamin A. Literally "dry eye".

APPENDIX 1

TABLE 1. AVERAGE HEIGHT AND WEIGHT OF CANADIANS BY AGE AND SEX

1953 Survey, Nutrition Division,
Department of National Health and Welfare,
Ottawa

	MALE		FEMALE	
	AVERAGE HEIGHT (inches)	AVERAGE WEIGHT (pounds)	AVERAGE HEIGHT (inches)	AVERAGE WEIGHT (pounds)
2 years	34.7	30	33.6	28
3 years	36.6	32	36.0	31
4 years	39.2	37	39.2	36
5 years	41.9	40	41.8	41
6 years	44.6	46	44.2	44
7 years	47.0	50	46.5	49
8 years	49.1	57	48.9	57
9 years	51.3	63	51.0	62
0 years	53.5	70	53.3	69
1 years	55.4	77	55.3	77
2 years	57.4	84	58.2	92
3 years	59.3	94	60.4	102
4 years	62.2	108	61.3	107
5 years	64.7	119	62.2	112
6-17 years	66.7	136	62.5	120
8-19 years	68.0	144	62.6	124
0-24 years	67.9	154	62.8	124
5-29 years	68.3	160	62.7	126
0-34 years	68.0	167	62.8	130
5-44 years	67.5	167	62.4	135
5-54 years	66.9	164	61.8	144
5-64 years	66.0	161	61.3	147
5 years nd over	65.5	155	60.6	138

MAY, 1954

TABLE 2. WEIGHT AND HEIGHT FOR AGE — COMPARISON OF REPORTED AVERAGES FOR PARTICULAR AREAS WITH THE CANADIAN NATIONAL AVERAGE (1953)

MALES (5-15 years)

AGE	TORONTO 1923	TORONTO 1939	LONDON, ENG. 1938	U.S.A. 1937-39	ENGLAND 1948	CANADA 1953	TORONTO 1923	TORONTO 1939	LONDON, ENG. 1938	U.S.A. 1937-39	ENGLAND 1948	CANADA 1953	AGE
	WEIGHT (pounds)						HEIGHT (inches)						
5	41.6	43.0	40.5	40.9	40	40	42.3	43.1	41.8	42.5	42.5	41.9	5
6	46.0	46.4	44.9	45.5	45	46	44.8	45.1	44.1	45.2	44.7	44.6	6
7	48.8	51.3	49.7	50.2	50	50	46.2	47.4	46.3	47.5	47.0	47.0	7
8	53.5	56.8	54.8	55.5	56	57	48.2	49.6	48.5	49.6	49.2	49.1	8
9	58.6	62.9	60.3	61.3	61	63	50.2	51.7	50.6	51.7	51.5	51.3	9
10	64.6	68.8	66.2	67.3	67	70	52.1	53.6	52.5	53.6	53.2	53.5	10
11	70.5	75.2	72.6	73.6	72	77	53.8	55.4	54.4	55.4	55.0	55.4	11
12	76.8	82.5	79.4	80.9	79	84	55.5	57.4	56.2	57.3	57.2	57.4	12
13	85.0	90.8	86.7	90.0	88	94	57.5	59.4	57.8	59.5	59.5	59.3	13
14	93.4	100	94.5	101	99	108	59.6	61.6	59.4	61.9	61.7	62.2	14
15	103	112	—	115	113	119	61.6	63.9	—	64.6	64.2	64.7	15

TABLE 2 (*continued*). WEIGHT AND HEIGHT FOR AGE — COMPARISON OF REPORTED AVERAGES FOR PARTICULAR AREAS WITH THE CANADIAN NATIONAL AVERAGE (1953)

FEMALES (5-15 years)

AGE	TORONTO 1923	TORONTO 1939	LONDON, ENG. 1938	U.S.A. 1937-39	ENGLAND 1948	CANADA 1953	TORONTO 1923	TORONTO 1939	LONDON, ENG. 1938	U.S.A. 1937-39	ENGLAND 1948	CANADA 1953	AGE
	WEIGHT (pounds)						HEIGHT (inches)						
5	40.5	42.0	39.7	39.7	40	41	42.5	43.0	41.6	42.4	42.2	41.8	5
6	44.9	44.9	43.6	44.1	44	44	44.7	44.8	43.7	44.8	44.2	44.2	6
7	47.6	49.9	48.1	49.0	48	49	46.0	47.1	45.9	47.1	46.5	46.5	7
8	51.9	55.0	53.2	54.3	52	57	48.0	49.3	48.0	49.2	48.7	48.9	8
9	57.4	61.2	59.0	60.1	57	62	49.9	51.4	50.2	51.3	51.0	51.0	9
10	63.3	67.8	65.6	66.6	63	69	51.9	53.4	52.4	53.3	53.0	53.3	10
11	70.7	75.8	73.0	74.5	71	77	54.0	55.7	54.5	55.6	54.7	55.3	11
12	78.8	86.1	81.5	83.9	80	92	56.2	58.2	56.7	57.9	57.0	58.2	12
13	88.9	95.4	91.2	94.0	90	102	58.4	60.2	58.8	60.1	59.5	60.4	13
14	98.0	103	102	102.5	102	107	60.1	61.5	61.0	61.6	61.5	61.3	14
15	104	109	—	110	112	112	60.9	62.3	—	62.7	62.7	62.2	15

TABLE 3. CANADIAN AVERAGE WEIGHTS FOR HEIGHT, AGE AND SEX

(in ordinary indoor clothing, without shoes)

MEN

HEIGHT IN FEET-INCHES	15 years	16-17 years	18-19 years	20-24 years	25-29 years	30-34 years	35-44 years	45-54 years	55-64 years	65 years and over
4 11	92	99	116	121	128	134	135	127	138	126
5 0	97	103	119	124	132	138	139	132	141	130
1	102	108	122	127	135	141	142	136	144	135
2	106	113	125	131	139	145	146	141	148	140
3	111	118	128	134	142	148	150	146	151	144
4	116	122	131	138	146	152	153	150	154	149
5	121	127	134	142	149	156	157	155	157	154
6	125	132	138	145	153	159	161	160	160	158
7	130	136	141	149	156	163	164	165	163	163
8	135	141	144	152	160	166	168	169	166	167
9	139	146	147	156	163	170	172	174	169	172
10	144	151	150	159	167	173	175	179	172	177
11	148	155	153	163	170	177	179	183	176	181
6 0	153	160	156	166	174	181	183	188	179	186
1	158	165	160	170	177	184	186	193	182	191
2	163	169	163	173	181	188	190	197	185	195
3	167	174	166	177	184	191	194	202	188	200

TABLE 3 (*continued*). CANADIAN AVERAGE WEIGHTS FOR HEIGHT, AGE AND SEX
(in ordinary indoor clothing, without shoes)

WOMEN

HEIGHT IN FEET-INCHES	15 years	16-17 years	18-19 years	20-24 years	25-29 years	30-34 years	35-44 years	45-54 years	55-64 years	65 years and over
4 8	96	105	100	106	110	115	126	130	134	120
9	99	107	103	108	112	117	127	132	137	124
10	101	110	107	111	114	119	128	134	139	128
11	104	112	110	113	117	122	130	137	141	132
5 0	107	115	114	116	119	124	131	139	144	136
1	109	117	118	118	122	126	133	142	146	140
2	112	120	121	121	124	129	134	144	148	144
3	115	122	125	123	127	131	135	146	151	148
4	117	125	129	126	129	133	137	149	153	152
5	120	127	132	128	132	136	138	151	155	157
6	123	130	136	131	134	138	140	153	158	161
7	126	132	140	133	137	140	141	156	160	165
8	128	135	143	136	139	143	143	158	162	169
9	131	137	147	138	141	145	144	160	165	173
10	134	140	151	141	144	147	145	163	167	177
11	136	142	154	143	146	150	147	165	169	181

APPENDIX 2

TABLE 1. CANADIAN DIETARY STANDARD FOR ADULTS, 1948

(The figures in the table give the maintenance allowances for the body weights shown plus additional needs for activity as indicated)

BODY WEIGHT[1] lbs.	DEGREE OF ACTIVITY	CALORIES	PROTEIN gm.	CALCIUM[2] gm.	IRON mg.	VITAMIN A[3] (as carotene) I.U.	THIAMINE mg.	RIBOFLAVIN mg.	NIACIN mg.	ASCORBIC ACID (C) mg.
					WOMEN					
80	Sedentary	1625	40	.40	12	2600	.45	.8	4.5	30
	Moderate	1900	40	.40	12	2600	.55	.9	5.5	30
	Heavy	2400	40	.40	12	2600	.70	1.2	7.0	30
100	Sedentary	1825	50	.45	12	3200	.55	.9	5.5	30
	Moderate	2100	50	.45	12	3200	.65	1.0	6.5	30
	Heavy	2600	50	.45	12	3200	.80	1.3	8.0	30
120	Sedentary	2125	55	.55	12	4000	.65	1.0	6.5	30
	Moderate	2400	55	.55	12	4000	.75	1.1	7.5	30
	Heavy	2900	55	.55	12	4000	.90	1.4	9.0	30
140	Sedentary	2325	60	.65	12	4600	.70	1.1	7.0	30
	Moderate	2600	60	.65	12	4600	.80	1.2	8.0	30
	Heavy	3100	60	.65	12	4600	.95	1.5	9.5	30
160	Sedentary	2525	70	.75	12	5300	.75	1.2	7.5	30
	Moderate	2800	70	.75	12	5300	.85	1.3	8.5	30
	Heavy	3300	70	.75	12	5300	1.00	1.6	10.0	30
In pregnancy[4] (latter half) add to the maintenance plus work		up to 500	25	1.0	3	2000	.15	.2	1.5	
in lactation[4] add to the maintenance plus work		up to 1000	25	1.0	3	2000	.30	.5	3.0	

TABLE I (*continued*). CANADIAN DIETARY STANDARD FOR ADULTS, 1948

BODY WEIGHT[1] lbs.	DEGREE OF ACTIVITY	CALORIES	PROTEIN gm.	CALCIUM[2] gm.	IRON mg.	VITAMIN A[3] (as carotene) I.U.	THIAMINE mg.	RIBOFLAVIN mg.	NIACIN mg.	ASCORBIC ACID (C) mg.
					MEN					
80	Sedentary	1625	40	.40	6	2600	.45	.8	4.5	30
	Moderate	2150	40	.40	6	2600	.60	1.1	6.0	30
	Heavy	2900	40	.40	6	2600	.85	1.4	8.5	30
	Very Heavy	3900	40	.40	6	2600	1.15	1.9	11.5	30
100	Sedentary	1825	50	.45	6	3200	.55	.9	5.5	30
	Moderate	2350	50	.45	6	3200	.70	1.2	7.0	30
	Heavy	3100	50	.45	6	3200	.95	1.5	9.5	30
	Very Heavy	4100	50	.45	6	3200	1.25	2.0	12.5	30
120	Sedentary	2125	55	.55	6	4000	.65	1.0	6.5	30
	Moderate	2650	55	.55	6	4000	.80	1.3	8.0	30
	Heavy	3400	55	.55	6	4000	1.05	1.6	10.5	30
	Very Heavy	4400	55	.55	6	4000	1.35	2.1	13.5	30
140	Sedentary	2325	60	.65	6	4600	.70	1.1	7.0	30
	Moderate	2850	60	.65	6	4600	.85	1.4	8.5	30
	Heavy	3600	60	.65	6	4600	1.10	1.7	11.0	30
	Very Heavy	4600	60	.65	6	4600	1.40	2.2	14.0	30
160	Sedentary	2525	70	.75	6	5300	.75	1.2	7.5	30
	Moderate	3050	70	.75	6	5300	.90	1.5	9.0	30
	Heavy	3800	70	.75	6	5300	1.15	1.8	11.5	30
	Very Heavy	4800	70	.75	6	5300	1.45	2.3	14.5	30
180	Sedentary	2725	75	.80	6	5900	.80	1.3	8.0	30
	Moderate	3250	75	.80	6	5900	.95	1.6	9.5	30
	Heavy	4000	75	.80	6	5900	1.20	1.9	12.0	30
	Very Heavy	5000	75	.80	6	5900	1.50	2.4	15.0	30
200	Sedentary	2925	80	.90	6	6600	.85	1.4	8.5	30
	Moderate	3450	80	.90	6	6600	1.00	1.7	10.0	30
	Heavy	4200	80	.90	6	6600	1.25	2.0	12,5	30
	Very Heavy	5200	80	.90	6	6600	1.55	2.5	15.5	30

[1] Body Weight or size is probably the most important cause of variations in nutrient requirements, but it is recognized that other factors also operate and that not all of the nutrients listed have been shown to vary with body size.

[2] Calcium — use these values for phosphorus also.

[3] Vitamin A given in terms of carotene; one quarter of these amounts may be used if taken as preformed vitamin A.

[4] Vitamin D — at least 400 International Units is also needed.

TABLE 2. CANADIAN DIETARY STANDARD FOR GIRLS AND BOYS, 1948

(The figures in the table give the maintenance allowances for body weights shown plus additional needs for activity)

BODY WEIGHT[1] lbs. (with approximate equivalent age in brackets)		CALORIES	PROTEIN gm.	CALCIUM[2] gm.	IRON mg.	VITAMIN A[3] (as carotene) I.U.	THIAMINE mg.	RIBOFLAVIN mg.	NIACIN mg.	ASCORBIC ACID (C) mg.	VITAMIN D I.U.
						GIRLS					
20	(1)	1050	35	1.0	6	700	.30	.50	3.0	30	400-800
30	(3)	1300	37	1.0	6	1000	.40	.65	4.0	30	400
40	(5)	1600	40	1.0	6	1300	.50	.80	5.0	30	400
50	(7)	1800	45	1.0	6	1600	.55	.90	5.5	30	400
60	(9)	2100	50	1.0	6	2000	.65	1.10	6.5	30	400
70	(10)	2300	55	1.0	6	2300	.70	1.15	7.0	30	400
80	(11)	2450	60	1.0	6	2600	.75	1.25	7.5	30	400
90	(12)	2475	70	1.5	6	3000	.75	1.25	7.5	30	400
100	(14)[4]	2500	75	1.5	12	3300	.75	1.25	7.5	30	400
						BOYS					
20	(1)	1050	35	1.0	6	700	.30	.50	3.0	30	400-800
30	(3)	1300	37	1.0	6	1000	.40	.65	4.0	30	400
40	(5)	1600	40	1.0	6	1300	.50	.80	5.0	30	400
50	(7)	1850	45	1.0	6	1600	.55	.90	5.5	30	400
60	(9)	2180	50	1.0	6	2000	.65	1.10	6.5	30	400
70	(10)	2300	55	1.0	6	2300	.70	1.15	7.0	30	400
80	(12)	2500	60	1.0	6	2600	.75	1.25	7.5	30	400
90	(13)	2650	65	1.5	12	3000	.80	1.30	8.0	30	400
100	(14)	2850	70	1.5	12	3300	.85	1.40	8.5	30	400
110	(15)[4]	3000	80	1.5	12	3600	.90	1.50	9.0	30	400

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[1] BODY WEIGHT or size is probably the most important cause of variations in nutrient requirements, but it is recognized that other factors also operate and that not all of the nutrients listed have been shown to vary with body size.

[2] CALCIUM — use these values for phosphorus also.

[3] VITAMIN A given in terms of carotene; one quarter of these amounts may be used if taken as preformed vitamin A.

[4] FOR CHILDREN heavier than these weights use adult standards plus an allowance for activity.

Nutrition Division
DEPARTMENT OF NATIONAL HEALTH & WELFARE

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APPENDIX 3

RECOMMENDED DAILY DIETARY ALLOWANCE, N.R.C., UNITED STATES, REVISED 1953

	AGE Yrs.	WEIGHT Kg. (lb.)	HEIGHT cm. (in.)	CALORIES	PROTEIN grams	CALCIUM grams	IRON mg.	VITAMIN A I.U.	THIAMINE mg.	RIBOFLAVIN mg.	NIACIN mg.	ASCORBIC ACID mg.	VITAMIN D I.U.
MEN	25	65(143)	170(67)	3200	65	0.8	12	5000	1.6	1.6	16	75	
	45	65(143)	170(67)	2900	65	0.8	12	5000	1.5	1.6	15	75	
	65	65(143)	170(67)	2600	65	0.8	12	5000	1.3	1.6	13	75	
WOMEN	25	55(121)	157(62)	2300	55	0.8	12	5000	1.2	1.4	12	70	
	45	55(121)	157(62)	2100	55	0.8	12	5000	1.1	1.4	11	70	
	65	55(121)	157(62)	1800	55	0.8	12	5000	1.0	1.4	10	70	
	Pregnant (3rd trimester)			add 400	80	1.5	15	6000	1.5	2.0	15	100	400
	Lactating (850 ml. daily)			add 1000	100	2.0	15	8000	1.5	2.5	15	150	400
INFANTS	1/12-3/12	6(13)	60(24)	Kg.x120	Kg.x3.5	0.6	6	1500	0.4	0.5	4	30	400
	4/12-9/12	9(20)	70(28)	Kg.x110	Kg.x3.5	0.8	6	1500	0.5	0.8	5	30	400
	10/12-1	10(22)	75(30)	Kg.x100	Kg.x3.5	1.0	6	1500	0.5	0.9	5	30	400
CHILDREN	1-3	12(27)	87(34)	1200	40	1.0	7	2000	0.6	1.0	6	35	400
	4-6	18(40)	109(43)	1600	50	1.0	8	2500	0.8	1.2	8	50	400
	7-9	27(59)	129(51)	2000	60	1.0	10	3500	1.0	1.5	10	60	400
BOYS	10-12	35(78)	144(57)	2500	70	1.2	12	4500	1.3	1.8	13	75	400
	13-15	49(108)	163(64)	3200	85	1.4	15	5000	1.6	2.1	16	90	400
	16-20	63(139)	175(69)	3800	100	1.4	15	5000	1.9	2.5	19	100	400
GIRLS	10-12	36(79)	144(57)	2300	70	1.2	12	4500	1.2	1.8	12	75	400
	13-15	49(108)	160(63)	2500	80	1.3	15	5000	1.3	2.0	13	80	400
	16-20	54(120)	162(64)	2400	75	1.3	15	5000	1.2	1.9	12	80	400

APPENDIX 4

Rat Experiments

The albino rat thrives in captivity. It is an ideal animal to test special diets in the classroom because it will eat anything. Its life span is 3 years which is comparable to 90 years in man, and so the results of a deficient diet show up very rapidly. Supplies for rat experiments may be purchased from any biological supply house.

They should be kept in a galvanized iron cage supplied with a feeding cup and a water container. Paper towels may be used to keep cages clean. Daily care is essential.

Care of Rats:

1. Change paper under cages daily.
2. See that water containers are working properly.
3. Check food supply daily.
4. Weigh each rat every week and record its weight.
5. At the end of the experiment, cages and food containers must be scrubbed and dried.
6. Discuss week-end care with instructor.

Breeding Directions:

1. Selected breeders are mated for the first time at between 100 and 120 days of age.
2. From 20 to 30 days are required for gestation period. Paper towelling may be given the female for her nest.
3. All litters are weaned at 24-28 days of age. Each member is weighed and those having a weight of less than 30 grams are discarded.
4. Following the weaning of a litter, the mother is given a rest period of about 2 weeks before being mated again.
5. The stock diet for breeders is as follows:

   ⅓ whole-milk powder
   ⅔ ground whole wheat
   Salt to equal 2% wheat
   Lettuce is given ad libitum and meat occasionally.

A. Milk

Milk *vs.* any carbonated drink. Use four rats for this test. Give two rats milk, water and whole-wheat bread ad libitum and two rats a carbonated drink and whole-wheat bread ad libitum. In addition, each rat should receive one drop of cod-liver oil weekly. At the end of two weeks, the diets should be changed so that the rats receiving milk will be given carbonated drink and vice versa. A record of weight should be made weekly. Plot these data on graph paper.

(Note: water is given to rats on milk diets.)

Experiment A is a very simple experiment that can be shown in any classroom with very little trouble. The experiments on protein and vitamins which follow require more attention but well repay the effort. If desired, complete diets may be purchased ready for use, e.g., a vitamin A deficient diet and a control diet containing vitamin A. Pure protein such as casein and lactalbumin may also be purchased in small amounts.

B. Protein Experiments

1. Casein *vs.* Gelatin. Use four rats in this test. They should be 24-28 days of age at the start and remain on the diet for 28 days. Put two rats on each of the following diets. At the end of two weeks, the diets could be changed so that the rats receiving Diet 1 will receive Diet 2 and vice versa. A record of weight should be made weekly. Plot these data on graph paper.

DIET 1		DIET 2	
Casein	18%	Gelatin	18%
Corn starch	52%	Corn starch	52%
Margarine (containing A)	8%	Margarine (containing A)	8%
Sucrose	10%	Sucrose	10%
Yeast	8%	Yeast	8%
Salt mixture	4%	Salt mixture	4%
Cod-liver oil	one drop weekly	Cod-liver oil	one drop weekly

2. Lactalbumin *vs.* Zein. Repeat the above experiment using actalbumin in place of casein and zein in place of gelatin.

3. Whole Wheat and Gelatin. Use four rats in this test. Put all four on the following diet. At the end of two weeks add 10 grams of gelatin to the diet of two rats and continue the other rats on the diet on which they started. Plot these data on graph paper.

Whole wheat	18%
Corn starch	52%
Sucrose	10%
Margarine (containing A)	8%
Yeast	8%
Salt mixture	4%
Cod-liver oil	one drop weekly

4. **Varying Percentages of Casein.** Use diet in Experiment 1 varying the amount of casein as follows: (1) 4%, (2) 9%, (3) 18%, (4) 36%. Alter the amount of corn starch to suit the varying amounts of casein.

C. Vitamins

1. **Vitamin A.** Animals used in these experiments must be specially depleted before this test begins. They should be obtained from a mother who has been on a vitamin A deficient diet throughout the lactation period. Control rats should be obtained from a normal mother. Rats should be 24-28 days old and remain on test for 5 weeks.

Use four rats for this test, two on the A-deficient diet, and two on the control diet. Each rat should be in an individual cage and given food and water ad libitum. Keep a weekly record of weight. At the end of five weeks the rats should be chloroformed and examined microscopically for gross changes in structure. Watch for eye trouble.

CONTROL DIET		A-DEFICIENT DIET	
Casein, A-free	18%	Casein, A-free	18%
Starch	65%	Starch	65%
Yeast, dried	8%	Yeast, dried	8%
Salt mixture	4%	Salt mixture	4%
Vegetable oil	5%	Vegetable oil	5%
Corn oil (containing D, E, and A)	1 drop weekly	Corn oil (containing D and E)	1 drop weekly

2. **Vitamin D.** Animals used in these experiments must be specially depleted before this test begins. They should be obtained from a mother who has been on a vitamin D deficient diet throughout the

lactation period. Control rats should be obtained from a normal mother. Rats should be 24-28 days old when put on test and remain on test for 3 weeks.

Four rats should be used for this test, two on the D-deficient diet and two on the control diet. Each rat should be in an individual cage, and be given food and water ad libitum. Keep a weekly record of weights. At the end of three weeks, one of the D-deficient rats should be given a curative dose of cod-liver oil. (Give daily for about 10 days.) The other D-deficient rat should remain on the D-deficient diet to act as a negative control. At the end of the curative period, the rats should be killed, the radius of each one split longitudinally and dipped into silver nitrate. The newly deposited bone shows up as a black line across the enlarged part of the radius. This is called the "line test". Varying degrees of calcification can be noted by increasing or decreasing the amount of the curative dose.

CONTROL DIET		D-DEFICIENT DIET	
Whole yellow corn, ground	76%	Whole yellow corn, ground	76%
Ground gluten	20%	Ground gluten	20%
Calcium carbonate	.75%	Calcium carbonate	3%
Sodium chloride	1%	Sodium chloride	1%
1 drop carotene and vitamin D in oil daily		1 drop carotene daily	

3. **Thiamine.** Use four rats in this experiment. Put two on the control diet and two on the thiamine-deficient diet. Give food and water ad libitum. Continue for four weeks. Try to cure thiamine-deficient rats with a pure solution of thiamine. Weigh the rats weekly and plot the data on graph paper.

CONTROL DIET		THIAMINE-DEFICIENT DIET	
Casein (vit.-free)	18%	Casein (vit.-free)	18%
Salt mixture	4%	Salt mixture	4%
Margarine	8%	Margarine	8%
Starch	49%	Starch	49%
Sucrose	10%	Sucrose	10%
Wheat-germ oil	1%	Wheat-germ oil	1%
Vitamin supplement including thiamine	10%	Vitamin supplement without thiamine	10%

Give one drop of cod-liver oil to each rat every week.

APPENDIX 5. FOOD EXCHANGE GROUPS

Each group below includes the kinds and amounts of food that have approximately the same nutritional value in protein, fat, and carbohydrates. The value is only approximate and for more exact information, the tables in Appendix 6 should be consulted.

Group 1—Milk Exchanges

Protein, 8 gm.; fat, 10 gm.; carbohydrate, 12 gm.
Approximate calorie value = 160

FOOD	MEASURE
Milk, whole	1 cup
Milk, evaporated	½ cup
Milk, powder, whole	¼ cup
Buttermilk*	1 cup
Milk, skim*	1 cup

*If fat-free, add two fat exchanges. Most commercial buttermilk is skimmed.

Group 2—Vegetable Exchanges

GROUP A VEGETABLES—negligible protein, fat, and carbohydrate if used in ordinary amounts. Little or no calorie value.

Beet greens
Celery
Chard
Cucumber
Endive
Lettuce
Mushrooms
Onions, green
Parsley
Pepper, green
Radish
Spinach
Tomatoes
Vegetable marrow
Watercress

GROUP B VEGETABLES—Protein, 2 gm.; fat, negligible; carbohydrate, 7 gm.

Approximate calorie value = 35
1 serving = ½ cup = 100 gm.

Asparagus
Beans, string
Beets
Broccoli
Brussels sprouts
Cabbage
Carrots
Cauliflower
Egg-plant
Onions
Peas, green
Pumpkin
Sauerkraut
Squash, winter
Turnip

Group 3—Bread Exchanges

Protein, 2 gm.; fat, negligible; carbohydrate, 15 gm.
Approximate calorie value = 75

	MEASURE
Bread, whole-wheat or white	1 slice
Cereal, cooked	½ cup
Cereal, ready to eat	¾ cup
Crackers, graham	2
Crackers, soda	3
Cornbread	1½″ cube
Corn	⅓ cup or ½ small ear
Dried beans, cooked (includes navy, lima, and kidney)	⅓ cup, cooked
*Ice cream, vanilla	⅓ cup
Macaroni, noodles or rice	½ c. cooked
Muffins	1 medium
Parsnips	⅔ cup
Potatoes, white boiled (2″ diameter)	1 small
baked (2″ diameter)	1 small
mashed	½ cup
Sponge cake, no icing	1½″ cube
Sweet potatoes or yams	¼ cup
Tea biscuit or roll (2″ diameter)	1

*Ice cream contains fat so calorie value is doubled.

Group 4—Fruit Exchanges

Protein, negligible; fat, negligible; carbohydrate, 10 gm. Fruits may be used fresh, cooked, canned or frozen, *unsweetened.* If sugar is added, the value changes according to the amount added.

Approximate calorie value = 40

	MEASURE
Apple	1 small, 2″ diameter
Apple sauce	½ cup
Apricots, dried	4 halves
Apricots, fresh	2 medium
Banana	½ small

Berries: blackberries, raspberries, strawberries	1 cup
Blueberries	⅔ cup
Cantaloup	¼, 6″ diameter
Cherries	10 large
Dates	2
Figs, dried	1 small
Grapefruit	⅓ small
Grapefruit juice	½ cup
Grape juice	¼ cup
Grapes	12
Honeydew melon	⅛, 7″ diameter
Orange	1 small
Orange juice	½ cup
Peach	1 medium
Pear	1 small
Pineapple	½ cup cubed
Pineapple juice	⅓ cup
Plums	2 medium
Prunes, dried	2 medium
Raisins	2 tablespoons
Tangerine	1 large
Watermelon	1 cup diced

Group 5—Meat Exchanges

Protein, 7 gm.; fat, 5 gm.; carbohydrate, negligible
All items are expressed in cooked weight.
Approximate calorie value = 75

	MEASURE
Meat, fish, and fowl (medium fat) (beef, lamb, pork, veal, liver)	1 ounce
Luncheon meats (canned)	1 slice, ⅙″ thick 4½″ diameter
Frankfurter	1
Cod, herring, etc.	1 ounce
Crab, salmon, tuna	¼ cup
Clams, oysters, shrimp	5

Sardines	3
Cheese, Cheddar	1 ounce
Processed	1 ounce
Cottage	¼ cup
Egg	1
*Peanut butter	1 tablespoon

*Peanut butter contains some carbohydrate.

Group 6—Fat Exchanges

Protein, negligible; fat, 5 gm.; carbohydrate, negligible
Approximate calorie value = 45

	MEASURE
Butter or margarine	1 teaspoon
Bacon, crisp	1 slice
Cream, light	2 tablespoons
Cream, heavy	1 tablespoon
Cream cheese	1 tablespoon
French dressing	1 tablespoon
Mayonnaise	1 teaspoon
Nuts	6 small
Oil or cooking fat	1 teaspoon
Olives	5 small

Protein, fat and carbohydrate negligible in the following:

- Coffee
- Tea
- Clear broth
- Bouillon (fat-free)
- Gelatin, unsweetened
- Rennet tablets
- Saccharin
- Spices
- Vinegar
- Cranberries, unsweetened
- Lemon
- Mustard, dry
- Pickle, dill, unsweetened
- Rhubarb, unsweetened

Adapted from material prepared for diabetics by:

American Diabetic Association
American Dietetic Association
Diabetic Branch of Public Health Service Federal Security
(Courtesy of Health Publications Institute Inc.,
216 North Dawson Street, Raleigh, North Carolina)

APPENDIX 6

NUTRIENT VALUE OF SOME COMMON FOODS

Most of these figures are taken from "The Table of Food Values Recommended for Use in Canada", which is available from the Department of Public Printing and Stationery, Ottawa, for $1.00. Other figures are from various sources.

List of Abbreviations Used in the Table

A.P.	as purchased	I.U.	international units	tsp.	teaspoon	pc.	piece	can.	canned	tr.	trace
E.P.	edible portion	Gm.	gram	tbsp.	tablespoon	fr.	fresh	lb.	pound	diam.	diameter
C.	cup (8 fl. oz.)	Mg.	milligram	sl.	slice	dr.	dried	oz.	ounce	med.	medium

FOOD	PORTION Measure		PORTION Weight	CALORIES	PROTEIN Gm.	FAT Gm.	CARBO-HYDRATE Gm.	CALCIUM Gm.	IRON Mg.	VITAMIN A I. U.	THIAMINE Mg.	RIBOFLAVIN Mg.	NIACIN Mg.	VITAMIN C Mg.
MILK														
Buttermilk	1 C.		8½ oz.	85	8.4	.2	12.2	.283	.2	tr.	.10	.43	.2	2
Evaporated	½ C.		4 oz.	165	8.4	9.5	11.9	.292	.2	480	.06	.43	.2	1
Dried, skim	¼ C.		1 oz.	102	10.0	.3	14.6	.364	.2	10	.10	.55	.3	2
Fluid, skim	1 C.		8½ oz.	84	8.3	.2	12.0	.290	.2	tr.	.09	.42	.2	2
Fluid, whole	1 C.		8½ oz.	153	8.3	8.3	11.6	.278	.2	380	.09	.40	.2	2
Cream, 18%	2 tbsp.		1 oz.	53	.8	5.1	1.2	.029	0	210	.01	.04	tr.	tr.
Cream, 32%	2 tbsp.		1 oz.	89	.7	9.3	1.0	.023	0	380	.01	.03	tr.	tr.
Ice cream, plain	½ C.		2¾ oz.	163	3.0	10.1	15.8	.133	.1	410	.03	.20	.1	
CITRUS FRUITS & TOMATOES														
Grapefruit	½ med.	A.P.	6 oz.	44	.6	.2	11.3	.025	.2	tr.	.04	.02	.2	45
Grapefruit juice can.	½ C.			45	.6	.1	11.8	.010	.4	tr.	.04	.02	.2	42
Lemon	1 med.	A.P.	3½ oz.	25	.6	.4	5.4	.025	.4	10	.02	.03	.1	31
Lime	1 med.	A.P.	1½ oz.	14	.2	tr.	3.7	.012	.2	0	.01	tr.	tr.	8
Orange	1 med.	A.P.	4¾ oz.	44	.9	.2	10.9	.032	.4	180	.08	.03	.2	48
Orange juice fr.	½ C.			53	1.0	.2	13.2	.023	.2	230	.10	.04	.2	71
Orange juice, diluted frozen	½ C.			44	.8	.2	11.1	.010	.3	100	.07	.02	.2	42
Orange juice can.	½ C.			64	.7	.2	16.7	.012	.4	120	.08	.02	.2	50
Orange & Grapefruit juice, can.	½ C.		4¼ oz.	63	.6	.1	16.7	.011	.4	50	.06	.02	.2	46
Tomato fr.	1 med.	A.P.	3½ oz.	21	1.0	.3	3.9	.011	.6	1,080	.06	.04	.5	19
Tomato can.	½ C.		4 oz.	23	1.2	.2	4.5	.013	.7	1,210	.07	.03	.8	22
Tomato juice can.	½ C.		4 oz.	25	1.2	.2	4.9	.008	.5	1,210	.06	.03	.9	18

OTHER FRUIT															
Apple	fr.	1 large	A.P.	5 oz.	76	.4	.5	19.7	.008	.4	120	.05	.04	.3	7
Apple juice, vitaminized		½ C.			60	.1	0	16.6	.007	.6	50	.01	.04	.1	38
Apple juice, plain		½ C.			60	.1	0	16.6	.007	.6	50	.01	.04	.1	2
Apple Sauce, sweetened,	can.	½ C.		4½ oz.	92	.3	.2	25.0	.005	.5	40	.02	.02	.1	1
Apricots	dr.	4 - 6 halves		1 oz.	79	1.6	.1	20.1	.020	2.3	1,430	.02	.06	.9	3
Banana	fr.	1 med.	A.P.	5 oz.	89	1.2	.2	23.0	.008	.6	430	.04	.05	.7	10
Blueberries	fr.	½ C.		2½ oz.	43	.4	.4	10.6	.011	.6	200	.01	.01	.2	7
Canteloup	fr.	½, 5″ diam.	A.P.	1 lb.	43	1.3	.4	9.8	.036	.9	7,290	.11	.09	1.1	70
Cherries	fr.	10 large	A.P.	2¾ oz.	43	.8	.4	10.4	.013	.3	440	.04	.04	.3	6
Cherries	can.	½ C. pitted		4 oz.	121	.7	.1	32.8	.013	.3	490	.03	.02	.1	3
Dates		3 - 4 pitted		1 oz.	85	.7	.2	22.6	.022	.6	20	.03	.03	.7	0
Grape juice, bottled		½ C.			80	.5	0	21.8	.012	.4	0	.05	.06	.2	10
Grapes, Malaga type	fr.	1 med. bunch	A.P.	3½ oz.	64	.8	.4	16.2	.016	.6	80	.06	.04	.2	4
Peaches	fr.	1 med.	A.P.	4 oz.	46	.5	.1	12.1	.008	.6	1,420	.04	.04	.9	7
Peaches	can.			4 oz.	78	.5	.1	20.9	.006	.5	520	.01	.02	.8	3
Pears	fr.	1 med.		3¼ oz.	47	.5	.3	11.8	.010	.2	10	.01	.03	.1	3
Pears	can.			4 oz.	78	.2	.1	21.2	.009	.2	tr.	.01	.02	.1	2
Pineapple	can.			4 oz.	90	.5	.1	24.3	.033	.7	90	.08	.02	.2	10
Pineapple juice	can.	½ C.			58	.4	.1	15.6	.018	.6	100	.06	.02	.2	11
Plums	fr.	3	A.P.	6 oz.	79	1.1	.3	20.2	.027	.8	550	.09	.06	.8	8
Plums	can.	2 - 3	A.P.	4 oz.	83	.4	.1	22.5	.009	1.2	250	.03	.03	.4	1
Prunes	dr.	6 med.	A.P.	2 oz.	137	1.2	.3	36.2	.028	2.0	960	.05	.08	.9	2
Raisins		¼ C.		1 oz.	81	.7	.2	21.4	.023	1.0	20	.04	.02	.2	tr.
Raspberries	fr.	¾ C.		3¼ oz.	52	1.1	.4	12.4	.036	.8	230	.02	.05	.3	21
Raspberries	can.	½ C.		4 oz.	123	.7	.6	32.0	.025	2.3	120	.02	.05		12
Rhubarb	fr.	¾ - 1 C.		3½ oz.	16	.5	.1	3.8	.051	.5	30	.01	—	.1	3
Rhubarb, sweetened, cooked		½ C.		4¾ oz.	137	.3	.1	35.1	.026	.2	16	—	—	tr.	2
Strawberries	fr.	10 large		3½ oz.	36	.8	.5	8.0	.027	.8	60	.03	.07	.3	58
Strawberries	can.	½ C.		4 oz.	120	.6	.2	32.2	.021	7.0					31
Watermelon		½ sl.	A.P.	5¾ oz.	22	.4	.2	5.2	.005	.2	450	.04	.04	.2	5
VEGETABLES															
Asparagus	fr.		E.P.	3 oz.	21	1.9	.2	3.3	.018	.8	850	.14	.16	1.2	28
Asparagus	can.	½ C. drained		3 oz.	20	2.0	.3	2.9	.016	1.6	680	.05	.07	.8	15
Beans, green, snap	fr.		E.P.	3¼ oz.	36	2.2	.2	6.9	.058	1.0	570	.07	.10	.4	23
Beans, green, snap	can.	½ C. drained		2¾ oz.	19	1.0	.2	3.5	.027	1.3	380	.03	.04	.3	4
Beans, navy	dr.			1½ oz.	152	9.6	.7	27.7	.073	3.1	0	.30	.10	1.0	1
Beans, yellow	fr.		E.P.	3¼ oz.	36	2.2	.2	6.9	.058	1.0	140	.07	.10	.4	18
Beans, yellow	can.	½ C. drained		2 oz.	14	.9	.1	2.9	.022	1.0	80	.02	.04	.3	4
Beet greens	fr.			4 oz.	35	2.3	.4	6.4	.134	3.6	7,600	.09	.20	.4	43
Beets	fr.		E.P.	3 oz.	38	1.4	.1	8.2	.023	.8	20	.02	.04	.3	13
Beets	can.	½ C. drained		2¾ oz.	34	.8	.1	7.8	.017	.6	20	.01	.02	.1	4

FOOD		PORTION			CALORIES	PROTEIN Gm.	FAT Gm.	CARBO-HYDRATE Gm.	CALCIUM Gm.	IRON Mg.	VITAMIN A I. U.	THIAMINE Mg.	RIBOFLAVIN Mg.	NIACIN Mg.	VITAMIN C Mg.
		Measure		Weight											
VEGETABLES (Continued)															
Broccoli	fr.		E.P.	2¾ oz.	27	2.6	.2	4.4	.104	1.0	2,800	.08	.17	.9	83
Brussels Sprouts	fr.		E.P.	2½ oz.	38	3.1	.4	6.2	.024	.9	280	.06	.11	.5	56
Cabbage	fr.	½ C. shredded		1¾ oz.	13	.7	.1	2.6	.023	.2	40	.03	.02	.2	25
Carrots	fr.		E.P.	3½ oz.	43	1.2	.3	9.3	.039	.8	12,000	.06	.06	.5	6
Carrots	can.	½ C. drained		3¼ oz.	28	.5	.4	5.8	.023	.5	15,810	.02	.02	.3	3
Cauliflower	fr.		E.P.	3 oz.	25	2.0	.2	4.2	.019	.9	80	.09	.08	.5	59
Celery, green	fr.	½ C. ¼ ″ pc.	E.P.	2 oz.	12	.8	.1	2.2	.030	.3	600	.02	.06		5
Chard	fr.			4 oz.	27	1.6	.2	5.1	.121	2.9	3,220	.07	.08	.5	44
Corn, yellow	fr.	1 ear	A.P.	½ lb.	89	3.2	1.6	17.6	.008	.4	335	.13	.10	1.4	10
Corn, yellow	can.	½ C. cream style		4 oz.	86	2.3	.6	18.5	.005	.6	230	.03	.06	1.0	6
Cucumber	fr.		E.P.	1¾ oz.	7	.4	tr.	1.4	.005	.2	0	.02	.02	.1	4
Lettuce, green, leaf	fr.	leaves 2 large		1¼ oz.	6	.4	.1	1.0	.022	.4	570	.01	.03	.1	4
Mushrooms	fr.		E.P.	3½ oz.	26	2.4	.3	4.0	.009	1.0	0	.10	.44	4.9	5
Onions	fr.		E.P.	3½ oz.	47	1.4	.2	10.3	.032	.5	50	.03	.04	.2	13
Parsnips	fr.		E.P.	3¼ oz.	73	1.4	.4	16.4	.051	.6	0	.07	.11	.2	16
Peas	fr.	½ C.	E.P.	2¾ oz.	71	5.0	.3	13.3	.016	1.4	510	.26	.12	2.0	20
Peas	can.	½ C. drained		3½ oz.	88	4.5	.6	17.2	.032	2.1	670	.12	.06	1.0	9
Peas, green	dr.			1 oz.	96	6.7	.4	17.1	.016	1.3	100	.22	.08	.9	1
Peppers, green	fr.	1 med.	A.P.	2½ oz.	17	.7	.1	3.4	.006	.2	370	.02	.04	.2	71
Potatoes, white	fr.	1 med.	A.P.	5¼ oz.	105	2.5	.1	24.1	.014	.9	30	.14	.05	1.5	21
Potatoes, sweet	fr.	1 med.	A.P.	5¼ oz.	158	2.3	.9	36.0	.039	.9	9,930	.12	.06	.8	28
Radish	fr.	3 med.	E.P.	1 oz.	6	.4	tr.	1.3	.011	.3	10	.01	.01	.1	7
Spinach	fr.		E.P.	3½ oz.	22	2.3	.3	3.2	.081	3.0	9,420	.11	.20	.6	59
Spinach	can.	½ C. drained		3 oz.	25	2.6	.5	3.1	.105	1.7	6,490	.02	.10	.3	12
Squash, winter			A.P.	5¼ oz.	47	1.7	.3	9.8	.038	.7	5,490	.06	.13	.6	9
Turnip, yellow	fr.	½ C. cubed	E.P.	3½ oz.	40	1.1	.1	8.9	.055	.4	330	.07	.08	.9	36
WHOLE GRAIN CEREALS															
Flour, whole wheat				1 oz.	95	3.8	.6	20.1	.008	.9	0	.12	.05	1.7	0
Oats, rolled, dry		¼ C.		1 oz.	98	3.6	1.8	17.0	.013	1.1	0	.18	.04	.2	0
Rice, brown		2 tbsp.		1 oz.	103	2.1	.5	22.0	.011	.6	0	.09	.01	1.3	0
Wheat, flakes		⅔ C.			107	3.2	.5	24.1	.014	.9	0	.02	.05	1.4	0
Wheat, germ		1 tbsp.			19	1.3	.5	2.5	.004	.4	0	.10	.04	.2	0
Wheat, shredded		1 biscuit		1 oz.	108	3.0	.8	24.0	.014	1.0	0	.08	.04	1.3	0
Wheat, whole		⅓ C.		1 oz.	102	3.0	.6	22.9	.011	1.0	0	.11	.04	1.2	0

REFINED CEREALS														
Barley, pearled	2 tbsp.		1 oz.	109	2.5	.3	23.6	.005	.6	0	.04	.02	.9	0
Cornflakes	¾ - 1 C.		¾ oz.	77	1.6	.1	17.0	.002	.3	0	tr.	.02	.3	0
Cornmeal, dry	3 tbsp.		1 oz.	102	2.2	.3	22.2	.002	.3	80	.04	.03	.4	0
Farina, dry	3 tbsp.		1 oz.	111	3.3	.2	23.2	.008	.3	0	.04	.02	.2	0
Flour, all purpose, white	¼ C.		1 oz.	99	3.4	.3	20.1	.005	.2	0	.02	.01	.2	0
Flour, enriched, white	¼ C.		1 oz.	99	3.4	.3	20.1	.005	.8	0	.12	.07	1.0	0
Macaroni, or Spaghetti	¼ C. 1″ pc.		1 oz.	108	3.6	.4	21.7	.006	.4	0	.03	.02	.6	0
Noodles	⅜ C. 1″ pc.		1 oz.	109	3.6	1.0	20.8	.006	.6	60	.06	.03	.7	0
Rice, white	2 tbsp.		1 oz.	102	2.2	.1	22.5	.007	.2	0	.02	.01	.5	0
Tapioca, minute	3 tbsp.		1¼ oz.	126	.2	.1	30.2	.004	.4	0	0	0	0	0
Wheat, puffed	1 C.		½ oz.	47	1.6	.2	12.0	.007	.5	0	tr.	.03	.7	0
BREAD, CRACKERS														
White, enriched	1 sl.		1 oz.	83	2.5	1.0	15.7	.020	.5	0	.07	.05	.7	0
White, no milk	1 sl.		1 oz.	80	2.5	.6	15.7	.009	.2	0	.02	.02	.4	0
White, 4% milk	1 sl.		1 oz.	82	2.6	1.0	15.5	.024	.2	0	.02	.03	.3	0
Whole Wheat*	1 sl.		1 oz.	72	2.8	.8	14.7	.015	.7	0	.05	.03	1.0	0
Raisin	1 sl.		1 oz.	85	2.1	.9	17.3	.024	.4	tr.	.02	.03	.3	0
Rye	1 sl.		1 oz.	73	2.7	.4	15.7	.022	.5	0	.05	.02	.4	0
Crackers, graham	2½ x 2¾″			39	.8	1.0	7.4	.002	.2	0	.03	.01	.2	0
Crackers, soda	2¾ x 2½″		1/5 oz.	25	.6	.6	4.4	.001	.1	0	tr.	tr.	.1	0
MEAT														
Beef, hamburg			4 oz.	364	18.2	32.	0	.025	2.6	0	.08	.16	4.3	0
Beef, round		E.P.	4 oz.	207	22.1	12.	0	.012	3.3	0	.09	.19	5.3	0
Beef, corned can.			2 oz.	122	14.4	7.	0	.011	2.4	0	.01	.14	1.9	0
Chicken, roaster		E.P.	4 oz.	227	22.9	14.3	0	.016	1.7	0	.09	.18	9.0	0
Lamb, chop		A.P.	6 oz.	460	19.3	41.9	0	.012	2.8	0	.17	.24	5.6	0
Lamb, leg		E.P.	4 oz.	266	20.4	19.8	0	.011	3.0	0	.18	.25	5.9	0
Pork, bacon, back		E.P.	3½ oz.	231	22.1	15.0	.3	.016	1.5		.74	.11	4.0	
Pork, bacon, side		E.P.	2 oz.	378	5.5	39.0	.7	.008	.5	0	.23	.07	1.1	0
Pork, chop		A.P.	5¾ oz.	380	21.3	32.	0	.013	3.2	0	.85	.18	2.9	0
Pork, ham, cured, boiled		E.P.	2 oz.	171	12.9	13.	0	.005	1.5	0	.57	.15	2.9	0
Pork, shoulder		E.P.	4 oz.	378	16.8	34.	0	.023	2.5	0	.80	.34	4.6	0
Pork, spareribs		A.P.	½ lb.	472	19.8	43.	0	.011	3.0	0	1.24	.24	5.3	0
Veal, leg, round		E.P.	4 oz.	187	22.1	10.	0	.012	3.3	0	.16	.30	7.4	0
Veal, stew meat		E.P.	2 oz.	131	10.4	10.	0	.006	1.5	0	.07	.14	3.5	0
VARIETY MEATS														
Bologna			2 oz.	133	8.9	9.5	2.2	.005	1.3	0	.07	.08	1.5	0
Heart, beef			4 oz.	125	19.4	4.3	.8	.010	5.3	30	.67	1.02	8.9	7

* Percentage of Whole Wheat unknown.

FOOD	PORTION			CALORIES	PROTEIN Gm.	FAT Gm.	CARBO-HYDRATE Gm.	CALCIUM Gm.	IRON Mg.	VITAMIN A I. U.	THIAMINE Mg.	RIBOFLAVIN Mg.	NIACIN Mg.	VITAMIN C Mg.
	Measure		Weight											
VARIETY MEATS (Continued)														
Heart, pork			4 oz.	134	19.4	5.5	.5	.04	3.1	30	.49	1.43	6.9	7
Kidney, beef			3½ oz.	141	15.0	8.1	.9	.009	7.9	1,150	.37	2.55	6.4	13
Kidney, pork			3½ oz.	114	16.3	4.6	.8	.011	8.0	130	.58	1.74	9.8	13
Liver, beef			3 oz.	115	16.7	2.7	5.1	.006	5.6	37,320	.22	2.83	11.6	26
Liver, pork			3 oz.	114	16.7	4.1	1.4	.008	15.3	12,070	.34	2.53	14.2	20
Tongue, beef			2 oz.	160	11.6	12.2	.2	.018	4.1			.10	1.3	0
Sausage, pork			3½ oz.	450	10.8	44.8	0	.034	2.5	0	.43	.17	2.3	0
Wiener	2 med.			206	11.4	16.4	2.2	.033	1.5	0	.13	.14	2.2	
FISH														
Cod		E.P.	4 oz.	86	19.0	.5	0	.012	.5	0	.07	.10	2.5	2
Haddock		E.P.	4 oz.	94	20.9	.1	0	.026	.8		.06	.09	1.6	
Halibut		E.P.	4 oz.	162	27.0	5.2	0	.015	.8	510	.10	.21	6.9	
Lobster can.	½ C.		2¼ oz.	60	12.0	.8	.3	.042	.5		.02	.05	1.4	
Mackerel		E.P.	4 oz.	218	21.5	14.0	0	.006	1.2	520	.17	.40	9.7	
Oysters	5 med.	E.P.	4½ oz.	102	12.2	2.6	7.0	.118	7.0	400	.19	.25	1.5	
Salmon fr.		E.P.	4 oz.	257	20.0	19.0	0		1.0	360	.12	.26	8.3	10
Salmon can.			4 oz.	196	22.9	10.9	0	.294	1.4	260	.04	.18	8.3	0
Whitefish		E.P.	4 oz.	178	26.0	7.4	0	.028	1.5		.10	.10	4.8	
OTHER PROTEIN FOODS														
Cheese, cheddar	1 ″ cube		¾ oz.	80	5.0	6.4	.4	.145	.2	280	tr.	.08	tr.	0
Cheese, cheddar, processed			1 oz.	105	6.6	8.5	.6	.191	.3	370	.01	.12	tr.	0
Cheese, cottage, skim milk	¼ C.		2 oz.	53	10.7	.3	1.1	.053	.2	10	.01	.17	.1	0
Cheese, cream	2 tbsp.		1 oz.	106	2.6	10.5	.6	.019	.1	410	tr.	.06	tr.	0
Eggs,	1 med.		1¾ oz.	72	5.7	5.1	.3	.024	1.2	510	.04	.13	tr.	0
Peanut Butter	1 tbsp.		½ oz.	81	3.7	6.7	2.9	.010	.3	0	.02	.02	2.3	0
Nuts, assorted, shelled	8 - 12			94	2.5	8.9	2.7	.014	.5	3	.089	.02	.6	tr.

FATS													
Butter	1 tbsp.	½ oz.	108	.1	12.2	.1	.003	0	500	tr.	tr.	tr.	0
Lard	1 tbsp.	½ oz.	128	0	14.2	0	0	0	0	0	0	0	0
Margarine, fortified	1 tbsp.	½ oz.	109	.1	12.2	.1	.003	0	530	0	0	0	0
Mayonnaise	1 tbsp.	½ oz.	106	.2	11.7	.4	.003	.2	30	.01	.01	0	0
Salad dressing, boiled	1 tbsp.	½ oz.	25	.7	2.	2.	.014	.1	80	.01	.03	tr.	tr.
Shortening	1 tbsp.	½ oz.	115		13.0								
SWEETS													
Candy, bar, average		2 oz.	271	5.2	13.0	34.9	.05	1.4		.03	.09	3.3	0
Candies, packaged, average		2 oz.	263	2.9	11.9	38.0	.04	1.6		.04	.07	2.3	0
Honey, strained	1 tbsp.	¾ oz.	62	.1	0	15.9	.001	.2	0	tr.	.01	tr.	1
Marmalades, jams	1 tbsp.	¾ oz.	56	.1	.1	14.2	.002	.1	tr.	tr.	tr.	tr.	1
Molasses, light	1 tbsp.	¾ oz.	50			13.0	.033	.9		.01	.01	tr.	
Sugar, brown	1 tbsp.	¼ oz.	33	0	0	8.6	.007	.2	0	0	0	0	0
Sugar, white	1 tbsp.	½ oz.	48	0	0	12.4	0	0	0	0	0	0	0
Syrup, chocolate		1 oz.	69	.7	.3	16.5	.005	.6		.01	.041	.1	
Syrup, corn	1 tbsp.	¾ oz.	57	0	0	15.	.009	.8	0	0	tr.	tr.	0
Syrup, maple	1 tbsp.	¾ oz.	50			12.8	.033	.6					
MISCELLANEOUS													
Beer, average	1 glass	8 oz.	114	1.4		10.6	.01	0	0	tr.	.072	.5	0
Carbonated, average	1 bottle	6 oz.	78			20.4							
Whiskey, average		1½ oz.	120										
Wine	1 wine glass	4 oz.	114			5.8							
Cake, plain, no icing	3″ x 2″ x 1½″	2 oz.	180	3.5	4.5	31.4	.085	.2	200	.02	.04	.2	0
Cookies, assorted	1, 3″ diam.		109	1.5	3.2	18.8	.006	.2	0	.01	.01	.1	0
Pie, 2 crust, fruit, average	1/6 med. pie		393	4.1	13.1	66.8	.025	1.2	278	.052	.037	.6	3
Pie, cream, average	1/6 med. pie		286	7.3	12.9	36.4	.113	.8	340	.050	.185	.3	0
Pie, 1 crust, average	1/6 med. pie		295	4.3	5.6	50.8	.046	1.1	861	.038	.075	.6	8
Griddle cakes, wheat (2)	4½″ diam.	3½ oz.	218	6.8	9.2	26.6	.158	.6	200	.06	.13	.3	tr.
Muffins	1 med.		144.	3.2	4.3	14.6	.031	.7	200	.805	.092	.6	0
Waffle, plain, average	5½″ diam.	2¾ oz.	232	5.1	14.0	21.4	.059	.9	178	.122	.159	.8	tr.
Olives, green, pickled,	1 large		7	.1	.7	.2	.005	.1	16	tr.			0
Pickles, dill	1 med.		6	.3	.1	1.0	.012	.6	160	tr.	.03	tr.	3
White Sauce, med.	¼ C.		107	2.6	8.1	6.1	.074	.2	328	.022	.104	.2	tr.

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